

A GUIDED ACTIVE PLAY INTERVENTION FOCUSED ON SELECTIVELY
IMPROVING LOCOMOTOR AND OBJECT CONTROL MOTOR SKILLS DURING
EARLY CHILDHOOD

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ABSTRACT

The relationship between level of proficiency in motor skill (MS) (for either locomotor (LOC) and/or object control (OC)) and increased physical activity (PA) participation in children aged 5 to 7 years is lacking in literature. The purpose of this study was to investigate the impact of a guided active play intervention program targeting LOC or OC skill development on MS proficiency and percent moderate to vigorous physical activity (MVPA). The LOC focused MS intervention group showed improvements for all sub-types (LOC, OC, and GMQ), however, the OC focused intervention group only showed significant improvements in LOC score. Minimal changes in MS scores were observed for the comparative group (SAS) that did not receive any specific intervention program. It is concluded that the relationship between PA and MS proficiency during early childhood needs to reflect the notion that PA intensity (>40% MVPA) is an important component influencing MS development.

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Chapter 1: Introduction

Purposes, Objectives and Hypotheses

The development of fundamental motor skills (FMS) during childhood is an effective way of increasing physical activity (PA) levels and improving health and fitness throughout the pediatric years (Stodden et al, 2008). During late childhood (10 to 12 year olds), children who are proficient in FMS appear to be more likely to increase PA participation (~30 minutes more a day) and cardiovascular-respiratory fitness levels during adolescences and youth (15 to 17 year olds). As a result a great deal of interest has accumulated in attempting to improve FMS during early to middle childhood. Of particular note is the identification that object control (OC) skills, in middle-late childhood period, seem to correlate with PA participation and fitness, in adolescents, more than locomotor (LOC) skills (Barnett et al, 2009). Moreover, a moderate correlation between weight status and locomotor skills has been reported, indicating that increasing proficiency of locomotor skills may help prevent unhealthy weight gain in adolescents. Despite the mounting evidence that FMS proficiency is related to greater PA participation in adolescents/youth; there is a lack of evidence in the literature regarding whether the relationship between level of proficiency in FMS (for either OC and/or LOC skills) and increased PA participation holds during the early childhood years (5-7yrs). Furthermore it is uncertain whether specific programs or interventions favoring locomotor and/or object control skills would be more influential in enhancing the overall status of FMS (i.e., gross motor quotient – GMQ) and/or the proficiency of locomotor and object control skills, respectively, when initiated during early childhood.

To address these issues the purposes of this study are:

- 1) To determine the energy expenditure (EE) and percent of moderate- to- vigorous physical activity (%MVPA) for children (5-7yrs) participating in a facilitated/guided active play program focused on either locomotor or object control programming.
- 2) To determine if children (5-7yrs) participating in a facilitated/guided active play program (7 weeks – 4 days/week) focused on either locomotor or object control programming experience improvement in overall motor skill (MS) proficiency, LOC and OC percentiles scores and/or improved proficiency in LOC and/or OC skills.

To successfully achieve the purposes of this study, several considerations are identified as important; for example:

- a) Is it possible to measure the proportion of upper body movement during the execution of OC motor skills (catching, throwing, striking, etc.) using motion sensors without the use of biomechanical analysis?
- b) Can upper body movements be assessed in children (5-7yrs) participating in a group program focused on FMS?

The hypotheses are:

- 1) A PA program (7 weeks) for children (5-7yrs) with a focus on locomotor skills will elicit greater levels of EE (kcal/session; kcal/min) and percent moderate-to vigorous PA (%MVPA) compared to that of a FMS program focused on object control skills.
- 2) A PA program with a focus on specific motor skills, LOC vs. OC, will result in a greater improvement for their respective skill component (i.e. locomotor group will have a higher score in the locomotor subtest compared to the object control subtest; etc.).

Literature Review

Gross Motor Skills – Developmental Profiles for Infants and Toddlers

Gross motor skills are essential during the early stages of development (0-3 years) because they allow for movement, stability and control of the body and objects while exploring the environment (Cools et al, 2009). There is a hierarchical approach to gross motor skills that can be categorized into three phases throughout the growth and development of a child. The three phases consist of the reflexive movement phase, the rudimentary movement phase, and the fundamental movement phase (Gallahue, Ozmun & Goodway, 2012).

The reflexive movement phase is the first form of movement and consists of two distinct stages. The first is the primitive reflexive stage, which occurs during the first 0-6 months of life and then is repressed. Some examples of primitive reflexes include sucking and palmar grasp. The second stage involves postural reflexes, which include actions such as crawling and stepping. There seems to be correlation between reflexive abilities at an early age that are related to voluntary movements later on during infancy (Gallahue, Ozmun & Goodway, 2012).

The rudimentary phase allows the child for more exploration and this phase is a sign of more motor control. The progression of rudimentary movements leads to voluntary movements during infancy, which leads to gross motor skills in children. The rudimentary phase involves motor actions that lead to independent walking. The progression generally includes sitting without support (the child is able to control their head, trunk and upper extremities). The next step is standing with support, and crawling on hands and knees, which occur by 9-10 months of age. The next steps are walking with

support and standing alone, generally occurring at 10-11 months. This finally leads to walking alone, which is generally observed between 12-13 months of age. Initially, during the development of walking, children (2-3 years of age) take more steps per unit of time to increase their walking speed. As the child gains neuromuscular control (>3yrs) walking patterns changes such that the number of steps per unit of time decreases and stride length increases. At this point there is an evident change in gait, which generally remains the same until approximately 7 years of age (Gallahue, Ozmun & Goodway, 2012).

Throughout development children do not necessarily proceed through the stages in the same sequence or at the same time; there are individual differences but according to research, 60% of children follow this movement pattern timing (Gallahue, Ozmun & Goodway, 2012). Once the child is able to walk with confidence they then enter the fundamental movement phase. The fundamental movement phase refers to movement, which focus on competencies and/or efficient mechanics (Gallahue, Ozmun & Goodway, 2012).

Fundamental Motor Skills – Developmental Profiles Early-to-Late Childhood

Fundamental motor skills (FMS) are the building blocks of movement patterns that lead to more complex skills. For this reason, FMS are generally categorized in different groups including locomotor, object control and sometimes stability. Locomotor (LOC) skills refer to children's movements that are fluid in nature; these include running, hopping, jumping, sliding, galloping, crawling, climbing, skipping and leaping (Gallahue, Ozmun & Goodway, 2012). Object Control (OC) skills refer to the manipulation of equipment; this includes striking, punting, kicking, trapping, throwing, volleying,

catching, dribbling, and ball rolling (Gallahue, Ozmun & Goodway, 2012). Stability refers to the ability to control ones center of mass; this includes bending, stretching, twisting, turning, swinging, body rolling, inverted supports, starting, stopping, dodging, and balancing (Gallahue, Ozmun & Goodway, 2012). There is some debate throughout literature with respect to the use of stability as a component of FMS, for the purposes of this study, stability was not a separate component because it is incorporated in both the locomotor and object control skills in the sense that you need stability and balance in order to perform the skills.

Age Trends

The impact of age on the development of FMS varies for each of the motor skills. It is important to note that not everyone reaches a proficient stage in each of the motor skills. That is, there isn't a certain point in time in which everyone reaches mastery or 100% proficiency (Goodway & Branta, 2003; Crow & Ward, 2003; Goodway, Robinson & Crow, 2010) of each motor skill.

Generally after walking is mastered children are more mobile, have more interactive experiences with their environment and they begin to increase their FMS for both locomotor and object control skills. The developmental progression does not follow a definitive sequence for FMS development; however some general trends occur over the childhood years. At the ages of 3-4 years about 50% of children are proficient at climbing and by the age of 5-6 years the percentage increases to about 75% (Seefeldt & Haubenstricker, 1982). For jumping, at the age of 3-4 years about 42% of children are proficient and the percentage increases to about 58% by the age of 5-6 years (Seefeldt & Haubenstricker, 1982). For hopping, about 30% of children between the ages of 3-4 years

are proficient and this increase to about 75% for the age of 5-6 years (Halverson & Williams, 1985). For object control skills like throwing, about 20% of children are proficient at the age of 3-4 years and by 5-6 years the percentage increase to 80% (Garcia & Garcia, 2002). For catching, at the age of 3-4 years about 28% of children are proficient and by the time children reach the age of 5-6 the percentage of children increases to about 57% (Payne & Isaacs, 2008; Gabbard, 2004).

The prevalence of locomotor skill mastery differs between each of the skills. Generally about 78% of children master running by age 6-7 years and by 8-10 years 85% of children master it, so it is evident that running is a skill that most children develop at an early age (Branta, Haubenstricker & Seefeldt, 1984). For the gallop 43% of 6-7 year olds have mastered the skill and by the age of 8-10 years, 55% of children have mastered the gallop (Clark & Whital, 1989). The hop shows a similar trend, the age of 6-7 years 37% of children have mastered the skill and that increases to only 51% by the age of 8-10 years (Seefeldt & Haubenstricker, 1982). The leap also seems to have a low percentage of mastery with only 25% of 6-7 year olds that have mastered the leap and by age 8-10 years the percentage of children increases to only 45%. For the jump, 33% of children master the skill between the ages of 6-7 years and by the age of 8-10 years the percentage of children that have mastered the jump is 44% (Branta, Haubenstricker & Seefeldt, 1984). The slide skill shows that 60% of children between the ages of 6-7 years have mastered the slide and by age 8-10 years 81% of children have mastered the slide (Gallahue, Ozmun & Goodway, 2012).

The prevalence of object control skill mastery also differs between each of the skills. By the age of 6-7 years 31% of children have mastered the dribble and this

percentage changes to about 66% percent by the age 8-10 years. The catch shows that 43% of children have mastered the skill and by 8-10 years 77% of children have mastered the catch (DuRandt, 1985). At age 6-7 years about 34% of children have mastered the kick and by the age of 8-10 that changes to 85% (Gamez et al, 2004). For the throwing skill, about 25% of children aged 6-7 years have reached mastery and by the age of 8-10 years 52% have reached mastery. So it is clear that there is a big change in object control manipulation for catching, kicking and throwing between the two age groups. The percentage of children who have mastered the skill of striking is 38% by the age of 6-7 years and 48% by 8-10 years (Seefeldt & Haubenstricker, 1982). The roll shows that 38% of children aged 6-7 years have mastered the skill and by age 8-10 years, 41% of children have mastered the skill of the roll. When comparing the object control skills to locomotor skill we can see that most of the object control skill shows a substantial variation between the two age groups (Gallahue, Ozmun & Goodway, 2012).

Sex differences

During the early years of life, MS development is characterized by the reflexive and rudimentary stages, with minimal differences between boys and girls. It is not until the fundamental movement phase where sex differences become obvious. Sex differences exist for all FMS, but for object control skills it is generally observed later for girls. Sex differences in performance related assessments are modest but variable over the early childhood period. When comparing boys and girls in product based assessments for agility, standing jump, catching, running speed, and distance throw the performance outcomes consistently favour boys in the early childhood period between the ages of 3 to 7 years (Robertson & Konczak, 2001; Butterfield & Loovis, 1993; Butterfield & Loovis,

1998; Thomas & Marzke, 1992; McKenzie et al, 2002; Morris et al, 1982). Girls had better performance outcomes for balance compared to boys during the early childhood period (Gallahue, Ozmun & Goodway, 2012).

The age and sex differences noted above provide evidence that children's FMS have varied developmental sequences/patterns as well as dissimilar rates of change for different skills. The importance of FMS development to specialized movement skills and/or life long physical activity has received considerable attention in the literature (which is reviewed below). Therefore, it is important to consider some of the factors or influencers of FMS development and assessment during childhood.

Factors Impacting FMS

The developmental pattern and timing of fundamental motor skills are influenced by many factors such as individual abilities, the nature of the task, environmental considerations, and the types of assessments to evaluate FMS. For the purposes of this thesis the primary factors will include: individual physical, perception of physical abilities, PA enjoyment, and the assessment protocols used to measure FMS.

Individual physical characteristics and abilities – briefly these factors can be organized in two categories: physical and mechanical factors. Physical factors refer to the differences in each person's development, which depends on heredity and environment (Gallahue, Ozmun & Goodway, 2012). These differences can be further subcategorized into two categories; 1) physical plus physiological fitness factors, which include body composition, muscle mass/strength, muscular endurance, aerobic endurance, flexibility; and 2) motor fitness factors, which include speed, agility, coordination, balance and power (Robertson et al, 1979). Individual constraints can affect movement patterns, for

example overweight children have a harder time running and jumping because they have more mass to carry through space (Gallahue, Ozmun & Goodway, 2012). Mechanical factors can be further subcategorized into: stability, giving force and receiving force. Stability elements include: center of gravity, line of gravity, base of support. Giving force elements include: inertia, acceleration, and action/reaction. Receiving force elements include: surface area, equipment size and distance. An example of a mechanical factor can be related to whether the child is running on grass or wood because it affects the child's ability to run with ease (Gallahue, Ozmun & Goodway, 2012).

Assessment protocols used to measure FMS - research over the past several years has focused on the type of assessment used and its contribution to determining the developmental pattern of FMS. In regard to the types of assessment tools used to measure FMS; there are generally two types i) product-orientated and ii) process-oriented assessments. Briefly, product-orientated assessments focus on the output of the skills and are compared to a criterion-referenced standard, which looks at the qualitative components that relate to a movement skill. Process-orientated assessments are compared to a stage and/or norm-referenced standard which compare child's performance to that of a normative group. A process-orientated approach allows for intra-individual comparisons. Furthermore, there are two different types of process-orientated assessments, a stage and a dynamic system. With a stage assessment system the child needs to complete all the criteria of a skill to be able to move on to the next stage. With a dynamic assessment system a child may be proficient in some parts of a skill but does not necessarily need to master all the criteria to be able to get a score. The importance of the type of assessment for FMS has lead to a greater degree of clarity around the progression

and development of FMS in regards to proficiency/competency and/or mastery. With process-oriented assessments the FMS proficiency and competency has been suggested to occur when at least one component of a skill is shown whereas FMS mastery occurs when all components of a skill are present.

Psychosocial traits such as self-efficacy, intention, motivation will also influence the expression of FMS in children. Additionally, the specific components of any task will also influence the degree of FMS exhibited by a child – therefore items such as the speed or distance of a task need to be considered. Environmental or external influencers (such as the lighting of the room, floor surface, and the size of equipment can also impact the level of FMS displayed. For this project, minimizing the influence(s) of the last items will be attempted by standardizing the task and environmental conditions for all children participating in the guided active play program throughout the study (see methodology). Finally, although the psychosocial aspects are difficult to control in children, an assessment of children’s psychosocial status (LeGear et al, 2012; Limbers et al, 2007) will be incorporated into the project.

Fundamental Motor Skills and Sport

Historically, FMS have been related to sport specific skills. Skills that are involved in sports are advanced versions of fundamental motor skills. These advanced and more complex skills are sometimes referred to as specialized motor skills, which are mature forms of FMS meaning they are a combination of movement skills that follow the rules of the given sport (Gallahue, Ozmun & Goodway, 2012). See Table 1 for an example of how FMS lead to specialized movement skills for basketball skills. Some sports require early specialization; these sports may include gymnastics, figure skating,

diving, and alpine skiing (Gallahue, Ozmun & Goodway, 2012). This is because these specific sports use different skill sets, for example in the case of figure skating, the early specialization refers to learning to ice skate.

Table 1. Fundamental locomotor, manipulative, and stability movements involved in the performance of basketball skills (Gallahue, Ozmun & Goodway, 2012)

Fundamental Movements	Specialized Movement Skills
MANIPULATION	
1. Passing	a) Chest pass b) Overhead pass c) Baseball pass d) Shovel pass e) Push pass
2. Shooting	a) Lay-up shot b) Two-hand set shot c) Jump shot
3. Bouncing	a) Stationary dribbling b) Moving dribbling c) Bounce pass
4. Catching	a) Pass above the waist b) Pass below the waist c) Rebounding d) Pass to the side e) Jump ball reception
5. Volleying	a) Tipping b) Center jump
LOCOMOTION	
1. Running	a) In different directions while dribbling b) In different directions without ball
2. Sliding	a) Guarding while dribbling
3. Leaping	a) Lay-up shot b) Pass interception
4. Jumping	a) Center jump b) Tip-in c) Rebounding d) Catching a high ball
STABILITY	
1. Axial movements	a) Pivoting b) Bending
2. Dynamic balance	a) Compensation for rapid changes in direction, speed, and level of movement
3. Dodging	a) Feinting with the ball

The progression of a fundamental movement skill (Table 1) depends on whether there were adequate amounts of quality guidance, instruction, encouragement and opportunity to practice these skills. With the proper amounts of supervision and guidance during skill development the child is able to learn the proper way to perform skills thereby enhancing scores for the process-oriented assessments. In addition if children are learning how to properly perform skills and learning about efficient mechanics it can potentially improve product-orientated assessment scores. Around the ages of 7 or 8 years children demonstrate more cognitive sophistication, improved group interaction, and also show a greater interest in organized competition and sport (Gallahue, Ozmun & Goodway, 2012). For this reason, it is suggested for children to develop FMS proficiency prior to this age in order to gain specialized movement skills and excel in sports, however it is not a requirement for athlete development. Figure 1 shows the FMS that are required for further sport skills. It is important to note that some sports require early specialization beyond the basic FMS, examples of this include alpine skiing or gymnastic (Gallahue, Ozmun & Goodway, 2012).

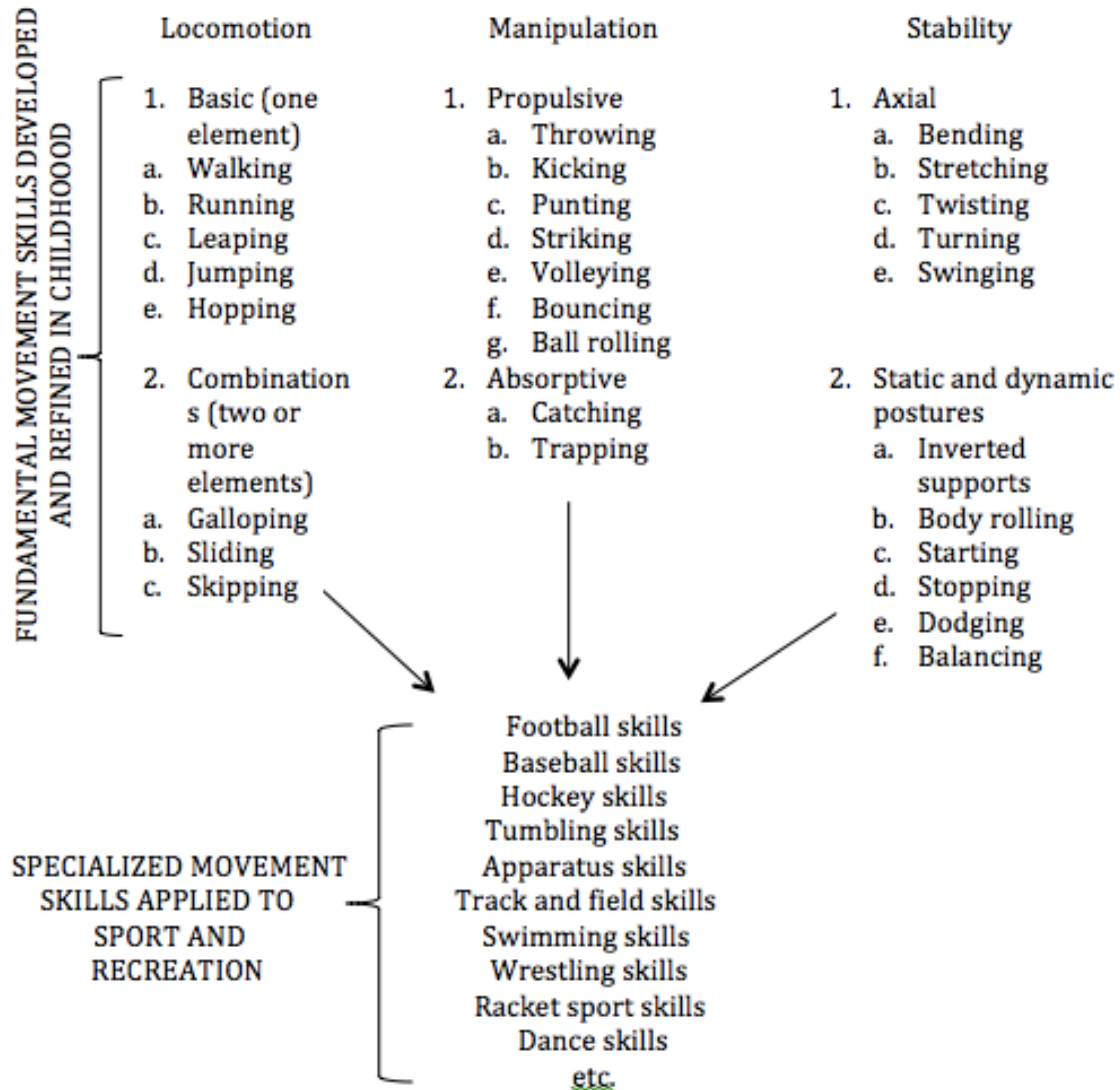


Figure 1. Fundamental motor skills should be proficient prior to the introduction of specialized movement skills (Gallahue, Ozmun & Goodway, 2012)

The Long-Term Athlete Development (LTAD) Model presented by Physical and Health Education Canada best represents this idea. The LTAD is a model that provides a chronological guide for athlete development. The first three stages of the model are related to physical literacy. According to Physical and Health Education Canada, physical literacy refers to the ability to participate in a variety of physical activities with confidence and competence in different environments that benefit the person as a whole. The first stage is called **Active Start** and occurs between the ages of 0-6 years and is related to the exploration of basic movement skills as well as the development of active habits. The second stage is **Fundamentals**, which occurs between the ages of 6-8 years for girls and 6-9 years for boys, this relates to developing fundamental motor skills. The third stage is **Learn to Train**, which occurs at the age of 8-11 years for girls and 9-12 years for boys, this relates to learning sport skills. The stages separate into two categories after the Learn to Train stage, one category/pathway focuses on developing excellence in the sports field (the stages include: Train to Train, then Train to Compete, then Train to Win), the other category is called Active for Life. The Active for Life stage relates to lifelong participation in physical activity and participation in sport (Lodewyk, 2011).

Fundamental Motor Skills and Health

The presence of FMS proficiency/mastery in children has recently been associated with improved health and fitness. It has been suggested that, children who are proficient in motor skills at a young age (before the age of 10 years) will be more likely to participate in physical activity throughout the pediatric years and into adulthood (Wrotniak et al, 2006), which is why this early age period has been identified as essential

in the development of motor skills and physical activity behaviours (Gallahue & Ozmun, 1998). There are different types of activities that children can partake in. For the purposes of this study, physical activity refers to activities of daily living that involves choosing an active lifestyle, for example riding a bike to school instead of driving, or taking the stairs instead of the elevator, etc. Non-organized or unorganized activities refer to activities that are self-directed/self-paced and are not structured/unregulated, for example playing in a playground individually or with a group. Organized activities refer to activities that involve some sort of supervision/leader (therefore it is structured but the children are free to do what they want meaning it is also self-directed), for example camp activities may included a leader telling a group of children what to play. Organized physical activities as well as non-organized physical activity are both a major contributor to children's overall physical activity. Sports are another category of activity that is structured and the activity is directed by a leader (coach, captain, etc.), examples of this are any team sports.

Stodden and colleagues (2008) reported in their theory of “Positive Spiral Engagement”, that increasing physical activity will increase perceptions of motor competence thereby increasing motor competence (see figure 2).

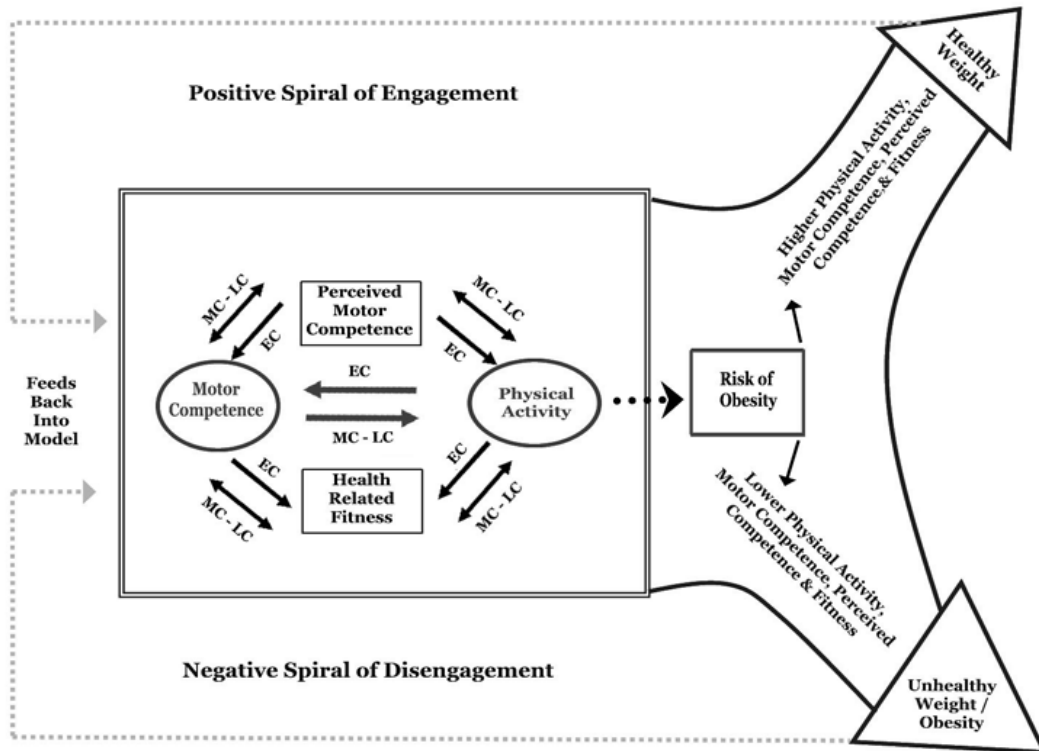


Figure 2. The relationship between motor skill competence and physical activity (Stodden et al, 2008)

The Stodden theory also suggested that children who participate in physical activity would increase their motor competence, this can be done through participation in both organized physical activity and sports. When children have developed FMS proficiency or mastery they are more likely to participate in both organized and non-organized physical activity (Stodden et al, 2008). In a study by Hardy et al, the results showed that for girls, organized physical activity showed a significant relationship with fitness and fundamental motor skill competency. These findings imply that early development of FMS may potentially lead to increased participation in sport. Hardy et al also suggests providing children with more opportunities to engage in daily-organized physical activity can assist in FMS development (Hardy et al, 2014).

Barnett et al, conducted a longitudinal study looking at the relationship between childhood motor skill proficiency and adolescent physical activity and fitness. The results showed that high motor skill development especially in object control skill during childhood in both boys and girls is an important part of having high-perceived sports competence which is crucial in determining adolescent activity participation and fitness (Barnett et al, 2008). This presents the idea that increasing FMS proficiency and mastery during childhood allows for children to feel confident to participate in sport, and it is well known that when children are active during childhood they are more likely to participate in sports during adolescence (Wrotniak et al, 2006).

Physical Activity Participation

The research evidence confirms that motor skill proficiency is correlated to increases physical activity participation (Butcher et al, 1989; Saakslahi et al, 1999; Fisher et al, 2005; Williams et al, 2009). Many researchers have shown differences within locomotor and object control and their effects on PA participation. A study looking at object control skill and physical activity participation, the results showed that children with object control proficiency were 10 to 20% more likely to participate in vigorous physical activity throughout adolescence but not associated with probability of participating in organized PA (Barnett et al, 2009). In a study by Hamstra-Wright et al. (2006) results showed that participation in organized and non-organized physical activity was related to locomotor skill competency.

FMS competency in early childhood has been linked to increases in moderate- to-vigorous physical activity and better cardiorespiratory fitness in later childhood (Gallahue & Ozmun, 1998). This suggests that if children are proficient in motor skills at a young

age then they are more likely to participate in activities that require those basic skills during their childhood, so this early age period is essential not only for the development of FMS but also for future PA participation. Therefore, the emergence and development of FMS during early-middle childhood is important for increasing PA levels and improving health and fitness throughout the pediatric years. In a study by LeGear and colleagues (2009), comparing children's motor skill proficiency to perceptions of competence showed that children had high perceptions of physical competence compared to their motor skill ability (LeGear et al, 2009). This brings forth the idea that physical competence needs to occur at an early age, telling us that there is a window of opportunity with children in terms of participation in physical activity. This early age period has been identified as essential in the development of motor skills and physical activity behaviours (Gallahue & Ozmun, 1998). These findings suggest that children are judging themselves at a young age; interventions should focus on developing confidence through skill development at an early age in order for children to become and also feel physically competent to participate in a variety of physical activities. These are not trivial matters, as childhood obesity rates are growing worldwide due to decreases in physical activity participation.

FMS and Cardiovascular-Respiratory Fitness

Many studies have shown that individuals with higher cardiovascular-respiratory fitness are less likely to develop cardiovascular-respiratory diseases (Lee et al, 2009). DeFina and colleagues (2014), showed that high levels of cardiovascular and cardiorespiratory fitness are related to decreased risk of having coronary heart disease.

Lee and colleagues (2009) showed that young individuals with higher cardiorespiratory fitness had significantly lower risk of having coronary calcification after 15 years. Since we know that PA and cardiorespiratory fitness have a positive correlation, we can conclude that increasing PA will reduce to the risk of developing cardiovascular-respiratory diseases. Earlier it was discussed that FMS proficiency and mastery during childhood will potentially lead to increases in participation in PA later in life (Wrotniak et al, 2006), leading to the idea that increasing FMS during childhood can be beneficial for cardiorespiratory fitness through increases in PA participation.

In summary, it is suggested that children and adolescents proficient in fundamental motor skills are associated with higher levels of PA, improvements in cardiovascular-respiratory fitness and psychosocial health (Gallahue, Ozmun & Goodway, 2012). Whether the improvements in FMS can be achieved through prescribed interventions at an early age is uncertain in the literature. Furthermore, whether children proficient in FMS at an early age are associated with increased PA participation and/or greater levels of cardiovascular-respiratory fitness are uncertain.

Fundamental Motor Skill and Interventions

The importance of movement is often overlooked because it is such a natural part of human life (Gallahue, Ozmun & Goodway, 2012). It is, however, crucial for a child's physical, physiological cognitive and social development. In fact, a common misconception is that children "naturally" learn FMS; however, children need to be provided with opportunities to practice them. Although a few studies have reported that a FMS intervention program can assist in increasing FMS in children; the results of these

studies are equivocal.

Motor skill intervention has been shown to increase fundamental motor skills (in terms of both proficiency and mastery) during middle-late childhood (Logan et al, 2011). Akbari and colleagues (2009) ran an experiment (40 boys aged 7-9 years) comparing a motor skill intervention group to a control group that was only involved with regular daily activities (consisting of soccer, computer games, cycling, etc.). The intervention consisted of a 1-hour period playing traditional motor skills games intervention three times a week for 8 weeks (24 hours in total). The results showed that the intervention group had a higher motor skill score ($P < 0.01$) than the no intervention control group. Bakhtiari and colleagues (2011) compared an intervention group (40 girls aged 8.4 – 9.4 years) that had selected exercises (no specific details) to a control group (no specific details) for 45 minutes 3 times a week for 8 weeks (2.25 hours in total). The results showed that the intervention group had a higher motor skill score ($p = 0.01$) compared to the control group, showing an increase in FMS proficiency. Cliff and colleagues (2011) ran an after-school intervention program (165 boys and girls aged 5.5 – 9 years) for 6 months (15 hours in total) comparing three groups. The age break down from this experiment was not clarified exactly however it was stated that the average age was 8.3 years with a standard deviation of 1. The first group had a weekly 90-minute group session on PA skill development; the second group had a dietary modification program (with parents), and the third group received a PA plus dietary modification program. The results showed that the interventions that included a PA intervention had better motor skill scores ($p < 0.01$) based on the age breakdown we may have seen these results because of the skew in age towards the older children, even though there were older children in each intervention group, it

would be interesting to see if these would remain for younger children. Cliff and colleagues (2007) found that a motor skill intervention program (13 boys and girls aged 8-12 years) for 10 weeks (total of 20 hours) that consisted of skill development and skill application activities showed increases in motor skills compared to pretest scores. Karabourniotis and colleagues (2002) compared a skill-oriented intervention group to a control group with regular physical education school curriculum and found that after a 12-week program with 45 first grade children (total of 16 hours) the intervention group had a higher motor skill score. Mitchell et al (2013) found that after a 6 week program with 701 children aged 5-12 years had improvements in motor skills with an intervention program focused on fundamental motor skills lessons. The age breakdown was 59% children between the ages of 5-7 years, 31% were between 8-10 years, and 10% were between 11-12 years. Although this study had a lot of participants in the early childhood years, they did not conduct object control assessments on the 5-7 year age group. Overall, it is clear that motor skill interventions are beneficial in improving FMS proficiency and mastery in later childhood and adolescence.

Based on the MS interventions that were previously mentioned, it can be conclude that there is insufficient evidence for children in the early age period (5-7 years). The studies that had a substantial number of children in the early age period showed increases in FMS proficiency, showing that interventions can help increase proficiency even at an early age, however, the studies did not include all aspects of motor skills, therefore future interventions should include both locomotor and object control assessments. A study looking at motor skill performance and PA in preschool children showed that motor skill performance and PA had a stronger relationship for 4 year olds compared to 3 year olds

(Williams et al, 2009). This suggests that there may be more positive outcomes with a motor skill program starting at the age of 4 years old. Either way, it is well known that increasing motor skill proficiency during early childhood (4-7 years) may be the best way to improve PA participation throughout adolescence (Wrotniak et al, 2006), however there is very little information on motor skill interventions that are able to improve MS proficiency.

Suggestions with duration of intervention

Ulrich (1985) who applied a 10-week movement program for the development of locomotor skills and found that children who attended the program made significant improvements in their performance compared to those who were engaged in free-play activities.

Bellows et al (2013) found that an 18 week intervention consisting of 15-20min of the Mighty Moves intervention for 4 days per week was an appropriate dose to see gross motor improvements but not for increasing PA levels or changing body mass index (BMI). They used a pedometer for the collection of PA, which could be one of the reasons why they did not see improvements in PA levels. This is because the pedometer only counts the number of steps taken, however it does not give any information on the intensity of the activity or the type of motion. The facilitation of the activity may also affect activity levels. West and Shores (2008) compared for styles of facilitation technique (skills and drills, scrimmage, free play and modeled play) and they showed that modeled play had the highest activity outcomes. This research implies that future interventions should provide better PA data collection than a pedometer and also having

some form of modeled play to effectively enhance FMS proficiency.

Music and rhythmic interventions

Painter (1966) found that rhythmic accompaniment enhanced FMS' learning and improved children's perceptual-motor abilities. Beisman (1967) reported a greater improvement in performance of FMS, such as throwing, catching, jumping, and leaping, when children participated in a movement program with rhythmic accompaniment, compared to a movement program without rhythmic accompaniment. Brown and colleagues (1981) also found that an integrated music and physical education program improved preschoolers' motor performance more than a movement exploration program did. Davidson and colleagues (2003) suggested that researchers should report more detail on the interventions in terms of intensity, duration, fidelity of FMS tasks and characteristics of facilitators and participants. Davidson reported that intensity should be addressed through indication of contact time involved and the different participant contacts. The duration should address the period in which the intervention contacts were conducted and how they were spaced. The fidelity refers to whether or not the intervention was delivered as intended and how this is monitored and measured. These important considerations will be adopted for the thesis project.

Quantifying Children's Physical Activity

The knowledge that there is a dose-dependent response between children's energy expenditure (EE) and the percentage of moderate-to-vigorous PA with expected health and fitness benefits has added fueled to the development of physical activity guidelines. As a result the quantification of children's PA that is, tracking EE is important when considering PA interventions. The finding that self-report of PA values are overestimated

by 183% (LeBlanc & Janssen, 2010), lead to the need for an objective measure of PA for children. Heart rate, pedometry, and accelerometry (ACC) are the most widely used methods of quantifying PA levels. When comparing these three methods in children it was reported that heart rate does not give an accurate reading when looking at low intensities or intermittent activity associated with children's play (Rowlands & Eston, 2007). Moreover these authors also state that pedometry does not account for intensity of the activity, which is important for assessment of children's health and fitness benefits. The most common PA monitors are uniaxial and triaxial accelerometers; albeit much debate has circled around which is the most effective way to assess energy expenditure. Uniaxial models of accelerometers measure acceleration solely in the vertical direction. The triaxial model GT3X⁺ was released to address the problem of accelerometer's inability to estimate lifestyle activities. In the 2005 study by Welk, and the 2005 study by Matthews, the results showed that when comparing uniaxial and triaxial accelerometers, uniaxial is a better predictor of locomotor activities such as walking and running, and triaxial is better for lifestyle activities involving children's games, sports, and household chores. In a 1998 study conducted by Eston and colleagues, and a 2004 study conducted by Rowlands and colleagues, it was concluded that vector magnitude counts (triaxial) are a better predictor for energy expenditure compared to vertical counts (uniaxial). Subsequently, it was concluded that when comparing a triaxial accelerometer to pedometry and heart rate, the triaxial accelerometer provided the best assessment of children's PA when predicting VO₂, the coefficient of determination was 0.650 for pedometry, 0.638 for heart rate, and 0.825 for the triaxial accelerometer (Eston, Rowlands & Ingledeew, 1998). This is particularly important when trying estimate energy

expenditure in a fieldwork setting. The Actigraph™ GT3x⁺ was used in this particular study when assessing children's movements in a self-directed active play program where movements occur in all three directions.

Assessing EE, LOC and OC Skills Using Accelerometry

There are conflicting ideas in literature regarding the estimation of energy expenditure and the body placement site for accelerometers. For EE, ideally, the accelerometer should be placed close to a body's center of mass (Ward et al, 2005). The hip or waist (lower trunk area) is the most common site to wear an accelerometer throughout literature. Hip ACC has been known to be a better predictor of habitual physical activity (Rosenberger et al, 2013). It has been suggested that increasing the number of ACC locations (hip, ankle, wrist, etc.) can improve the standard error of estimation for EE (Cleland et al, 2013).

In regard to the assessment of movement/motion using triaxial ACC, minimal reports exist in the literature. It has been shown that ACC worn on the wrist is associated with more motion, expressed with greater number ACC counts, but with a small contribution to the EE associated with arm motion (Vanhelst et al, 2012). The contribution of ACC placed on the ankle to the assessment of motion, independent of EE has not been systematically studied, although it has been suggested that it may reflect lower limb contribution to locomotor skills with human movement (Guinhouya et al, 2005). Although limb motion (arm and leg – either separately and/or in combination) assessed by ACC does not indicate the degree of proficiency of FMS, it may be sufficient to identify the proportion arm and or leg motion occurring during children's active play.

This project will attempt to identify the arm and/or leg motion of children's active play during LOC and OC interventions.

Assessing Fundamental Motor Skills

Many tests have been developed to assess FMS. The tests are age group specific and differ in the: time required to administer the test(s), number of items/questions, equipment and space required, raw score conversion and cost. Some assessment tools are developed to detect dysfunctions or inefficient movement behaviours (Davies, 2003). Generally the choice of test is dependent on the purpose of the study. For the purposes of this study, a process-orientated test with a dynamic system would be ideal to analyze personal improvement and allows for the assessment of specific elements of a motor skill.

The process-orientated dynamic assessment tools that are available include the: Motoriktest für Vier- bis Sechsjährige Kinder (MOT 4-6), Movement Assessment Battery for Children (Movement-ABC), Peabody Development Scales (PDMS), Körperkoordinationstest für Kinder (KTK), Test of Gross Motor Development (TGMD), the Maastrichtse Motoriek Test (MMT), and the Bruininks-Oseretsky test of Motor Proficiency (BOTMP). Although the assessment tools vary in specific applications, the basic concepts of assessment all operate similarly (Cools et al, 2009).

The MOT 4-6 is outdated because they use older normative data. The Movement ABC test does not give information on skill mastery and it is not specifically designed for young children. The PDMS-2 is age appropriate for this study however the completion of the test is too long for younger children. The KTK test is not age appropriate for younger children. Although the MMT may be a highly efficient test, the age range is rather small and therefore not useful for this study. The BOT-2 test is also too long to complete for

young children and the standardization of the examination is rather difficult. The TGMD-2 is age appropriate, it includes qualitative aspects of movement behavior, and it provides information on skill mastery. A weakness that the test may have is that it does not include the evaluation of fine or stability movement skills. The TGMD-2 test is the most commonly used test for the assessment of fundamental motor skills throughout literature, which is also one of the main reasons this test was chosen to be the assessment tool.

The TGMD-2 is a process-orientated and norm referenced measure of gross motor skills. It is comprised of two subtests: locomotor and object control. Six different locomotor skills are assessed including: run, hop, horizontal jump, gallop, slide, and leap. Six different object control skills are assessed including: striking a stationary ball, dribble, kick, overhand throw, underhand roll, and catch.

The administrator demonstrates each skill once for the child and the child then gets a practice run before two trials that will be scored. The scoring process includes checking for certain performance criteria (3-5) for each skill. If the child completes the criteria then they get a score of 1, if not then they get a score of 0. Each of the skills (from trials 1 and 2) are added and all skills in each subtest are added to obtain a single locomotor score and object control score which are then used to calculate the gross motor quotient (GMQ) to achieve an overall assessment of FMS based on raw scores and on percentiles for each child. A high GMQ score indicates well-developed FMS and a low score is indicative of weak FMS (William et al, 2009; Ulrich, 2000).

TGMD2 validation

The correlation for subtests (locomotion and object control) is 0.97-0.99 with a Pearson correlation (r) value between 0.84-0.96. The test-retest reliability for the

locomotion subtest has an r-value of 0.85, for object control the r-value is 0.88, and GMQ has an r-value of 0.91 (Ulrich, 2000). There are some assumptions that are important to point out when using the Test of Gross Motor Skills as an assessment tool. The assumptions are that there is a correlation with chronological age, that groups of individuals be stratified as average, below average and above average, that the items correlate highly with total score of subtests, the subtest composites correlate with each other, and lastly the factor analysis shows that goodness of fit indexes ranging from 0.90 to 0.96 The TGMD2 was chosen because it is widely used as a gold standard throughout literature in assessing fundamental motor skills in children between 4 to 7 years (Evaggelinou, Tsigilis & Papa, 2002; Hardy et al, 2010; Williams, et al, 2009).

Psychosocial and Enjoyment benefits from PA interventions

It is well known that, increasing PA levels contributes to improvements in psychosocial wellbeing (Paluska & Schwenk, 2000). It has been suggested that PA intervention programs can enhance children's self-perception and enjoyment levels, thereby contributing to increased PA participation later on in life (Biddle et al, 2003; Stein et al, 2007). Higher levels of self-perception leads to increases in PA participation (LeGear et al, 2009), this is because children who see themselves as competent in motor skill level, have the confidence to participate in activities that require those skills compared to those that believe they do not have motor skill competency (Schmalz et al, 2007).

Chapter 2 - Methodology

Participants:

This study was conducted in accordance with Canada's Tri-Council Policy for the Ethical Conduct of Research Involving Humans. Written consent was obtained from parents/guardians of the children involved with this study. Children also provided their own verbal assent to participate. Children were recruited to participate in this study from a local community center summer camp program, specifically the children's physical activity component. Children (and their parents/guardians) wishing to participate in the study were given an information and orientation session prior to the commencing sessions. The Human Participant Research Ethics Committee at York University granted approval for all aspects of this study.

Study Design:

Children (n=52) were recruited from two individual seven-week physical activity programs (4d/wk; 55±3 min/d). One program (n=38) located at Gosford (GS) has two PA sessions (10:30 to 11:30am and 11:30am-12:30pm) which were assigned either a locomotor (GS-LOC) skills program or an object control (GS-OC) skills program. The other program located at St. Augustine (SAS) (n=14) has a PA session from 1-2pm but without any specific focus on FMS, but rather sports skills and drills. The study design is found in Figure 3, and the days in which data was collected in presented in Table 2.

		Program Type		
		Gosford Locomotor Group (GS1) (n=20)	Gosford Object Control Group (GS2) (n=20)	St. Augustine Comparative Group (SAS) (n=20)
Time (7 weeks)	Pre	<u>Fundamental Motor Skills</u> <ul style="list-style-type: none"> • GMQ raw score and percentile • LOC standard score and percentile • OC standard score and percentile <u>Physical Activity</u> <ul style="list-style-type: none"> • Percentage of mod-vig physical activity (%MVPA) • Physical activity attractiveness 		
	Post	<u>Fundamental Motor Skills</u> <ul style="list-style-type: none"> • GMQ raw score and percentile • LOC standard score and percentile • OC standard score and percentile <u>Physical Activity</u> <ul style="list-style-type: none"> • Percentage of mod-vig physical activity (%MVPA) • Physical activity attractiveness 		

Figure 3: Design of Study: Program Type (3-levels) by Time (pre vs. post).

Table 2. Data collection during the length of the summer camp program

	PRE	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	POST
PA	✓	✓	✓	✓	✓	✓	✓
GMQ	✓						✓
LOCOMOTOR	✓						✓
OBJECT CONTROL	✓						✓

For the GS programs the PA sessions consist of approximately five to six assigned self-paced (unregulated) age appropriate cooperative games. Generally the two intervention groups played games specific to the motor skill intervention goal and taken from a compendium of activities (Landy & Landy, 1993; Belcastro et al, 2012; Mackenzie et al, 2001). For example the locomotor group played games that mainly require the skills of running, hopping, jumping, leaping, sliding, and galloping, while the object control focused intervention group played games that require skills such as striking, rolling, throwing, dribbling, kicking, and catching. In addition to the 55 minutes of activity, a warm-up period and a water break (approximately half way through the session) were included. The children's PA included self-paced (self-directed) activity delivered in a guided/facilitated active play program, which involves experienced Kinesiology undergraduate majors serving as positive role models and encouraging children to participate in a ratio of five-children/one-undergraduate student. At no time are the children forced and/or ridiculed for not participating. Their engagement in the games is completely voluntary and under their control. All children are able to participate without feelings of incompetency; and provided the opportunity to cooperative and socialize with peers while having fun and being active. For the SAS program the children followed a sport camp PA session, which incorporates sport specific skill, (such as basketball, volleyball, soccer, etc.) during the one-hour of PA time. All activity sessions were conducted in temperature controlled $20 \pm 1^{\circ}\text{C}$ gymnasiums. The SAS program served as a comparative group, rather than a control group for the program.

Measurement of Physical Activity

Physical activity was quantified by accelerometry (Actigraph GT3X⁺) during the hour-long active play program and expressed as vector for ten-second epochs (Bonomi et al, 2009). To classify the intensity of PA, the ACC data for each session/child were expressed in metabolic equivalents (METs) and EE (kcal) using two different linear regression equations derived from the children in the camp. The METs (1MET = 4.82 mL O₂·kg⁻¹·min⁻¹) was estimated using a linear regression, where $y=0.0045(\text{ACC counts}/10\text{sec}) + 0.9912$ ($r=0.89$). Oxygen consumption (mLO₂·kg⁻¹·min⁻¹) was estimated by linear regression, where $y=0.0025(\text{ACC counts}/10\text{sec}) + 2.2266$ ($r=0.98$). Briefly the ACC calibration was accomplished with a treadmill protocol of rest, 4, 6 and 8 km/h (0% grade) treadmill activity (Belcastro et al, 2012) and using a CosMed² oxygen collection system for VO₂ determination. Cutoffs for activity levels will be; 0 – 1.5 METs classified as sedentary; 1.6 to 2.9 for very light; 3 – 3.9 METs classified as light activity; 4-5.9 METs classified as moderate; and >6 METs classified as vigorous (Romanzini et al, 2012).

Measurement of Growth and Body Composition

The assessments of growth and body composition are important when assessing children's motor skills because individual physical characters influence motor skills (see factors impacting FMS). Standing height was measured using a standiometer. Without shoes, children were directed to stand erect with feet together ensuring their heels, buttocks, back and head was in contact with the standiometer. Height was recorded to the nearest 0.5 cm. Wearing light clothing and standing in sock feet, body mass was

measured using an electronic scale to the nearest 0.1 kg. Body mass index was calculated as body mass divided by height (BMI = kg/m²). Waist circumference measurements were taken to the nearest 0.1 cm (Belcastro et al, 2015). For all assessments the average of three trails were calculated.

Measurement of Fundamental Motor Skills

The Test of Gross Motor Development 2 was used to assess locomotor skills (run, hop, leap, horizontal jump, slide, gallop) and object control skills (striking, kicking, dribbling, catching, throwing, rolling). Motor skill testing was conducted during the first and last week of the camp (before and after the intervention program) during scheduled gym time with the procedures outlined in the TGMD2 examiners manual (Ulrich, 2000).

Since the TGMD2 assessment requires practice, Kinesiology student volunteers were trained to conduct the assessments. An interclass correlation coefficient was calculated (see table 3) to ensure standardization. Table 3 indicates that the average measures between the raters are 0.97 with a 95% confidence interval of 0.94 to 0.99 indicating good agreement.

Table 3. Interclass correlation coefficient of kinesiology student volunteers

	Interclass correlation ^a	95% Confidence Interval
Single measures ^b	0.58	0.40 to 0.80
Average measures ^c	0.97	0.94 to 0.99

^a The degree of absolute agreement among measurements. ^b Estimates the reliability of single ratings. ^c Estimates the reliability of averages of 28 ratings.

Physical Activity Attractiveness

Physical activity attractiveness is an important component of PA participation; if one enjoys activity then they are more motivated to participate in sports and games compared to someone who does not enjoy being active (Rose et al, 2009). The Children's Attractiveness to Physical Activity (CAPA) was used to quantify children's enjoyment of PA. The questionnaire consists of 20 questions in five subscales which included liking of games and sport, liking of physical exertion and exercise, liking of vigorous intensity PA, peer acceptance in games and sport and importance of exercise (Rose et al, 2009). The questions are scored in Likert scale format with five options (strongly agree, agree, neutral, disagree, strongly disagree). Children completed the questionnaire with the help of administrator, who read the instructions and the question to the child in the form of an interview (Belcastro et al, 2015).

Quality of Life Inventory (PedsQL 4.0)

The quantification of physical health and psychosocial health was undertaken with a children's quality of life inventory (PedsQL) (Varni, 2007). The physical health summary score is evaluated from 8 questions related to a child's perception of their physical functioning. The psychosocial health summary score is evaluated from 5 emotional functioning questions, 5 social functioning and 5 school functioning questions (Belcastro et al, 2015).

Children completed the questionnaire with the help of administrator, who read the instructions and the question to the child in the form of an interview. For young children a modified questionnaire sheet including a three-face response choice (0 = not at all a

problem, 2 = sometimes a problem, 4 = a lot of problem) was used (Limber, Newman & Varni, 2007). The answers are converted to a 100 scale score and each category is averaged. The psychosocial health summary score derived from the scores from emotional, social, and school functioning score divided by the number of questions answered by each category (Limber, Newman & Varni, 2007). The physical health summary score is the same as the physical functioning score. The reliability of the questionnaire is 0.88 for the child self-report and 0.90 for the parent proxy-report.

Program Information

The children were assigned randomly to each intervention group. In each session 5 games were chosen at random from a pool of games according to each motor skill group. The main goals of each session were to start with a warm up game, chose the games that would increase practice of the specific motor skill group. Although the main focus of the intervention was to provide an opportunity for the children to learn and practice their motor skills, remaining physically active was also important.

All community summer camps (GS1, GS2 and SAS) were seven weeks in duration from June 30th till August 15th from Monday to Friday (n=33 weekdays). During the first week (June 30th to July 4th) all initial assessments were collected. The last week of the camp (August 11th to 15th) was identified for final assessments. As a result the children received MS specific programming for 19 out of 23 weekdays. Of the 19 days, physical activity data was collected for each group on the same twelve days distributed throughout the five weeks of the intervention (Table 4). On the other 7 days the program was delivered and data collected however not every group may have been scheduled for

physical activity time due to slight variations in camp schedules and/or four missed days due to statutory holidays and camp field trips. As a result of community camp schedules and non-physical activity sessions the children on average participated in 3.8 hours/wk of PA programming. A full day list of recreational activities is included in the appendix.

Table 4. A list of the twelve common days and time period over which physical activity measurements occurred at each site - Gosford LOC (GS1), Gosford OC (GS2) and SAS (comparator group). The number of children sampled from the group sessions is indicated in brackets by program.

Day		Camp	Time (min)
1 (Week 1)	July 10th	GS1 (n=5)	52
		GS2 (n=5)	50
		SAS (n=4)	60
2 (Week 2)	July 14th	GS1 (n=7)	60
		GS2 (n=6)	55
		SAS (n=5)	60
3 (Week 2)	July 16th	GS1 (n=12)	53
		GS2 (n=12)	50
		SAS (n=5)	60
4 (Week 2)	July 18th	GS1 (n=12)	53
		GS2 (n=9)	47
		SAS (n=5)	60
5 (Week 3)	July 21st	GS1 (n=11)	59
		GS2 (n=11)	51
		SAS (n=3)	60
6 (Week 3)	July 22nd	GS1 (n=5)	57
		GS2 (n=5)	57
		SAS (n=6)	60
7 (Week 3)	July 23rd	GS1 (n=12)	56
		GS2 (n=12)	51
		SAS (n=5)	60
8 (Week 3)	July 24th	GS1 (n=12)	59
		GS2 (n=11)	51
		SAS (n=4)	60
9 (Week 4)	July 30th	GS1 (n=11)	62
		GS2 (n=11)	48
		SAS (n=3)	60
10 (Week 4)	August 1st	GS1 (n=4)	62
		GS2 (n=5)	54
		SAS (n=2)	50
11 (Week 5)	August 5th	GS1 (n=4)	63
		GS2 (n=4)	58
		SAS (n=4)	60
12 (Week 5)	August 6th	GS1 (n=4)	59
		GS2 (n=4)	56
		SAS (n=5)	63

Intervention Programming

The two intervention programs provided an opportunity for children to practice specific LOC (GS1) or OC (GS2) motor skills while maintaining an adequate level of physical activity – both important goals for the programs. This was achieved through the selection of specific games (Belcastro et al, 2012). Games were divided into two categories based on the subset of skills required to participate in each game (see Table 5 for games lists).

Table 5. List of games for the motor skill intervention groups

Locomotor Games (GS1)	Object Control Games (GS2)
Fishes and whales	Racket balloon (strike)
Crocodile crocodile	4 way soccer (kick)
Blob tag	Clear out (kick)
Toilet tag	Clear out (throw)
Bacon tag	Simon says (dribble)
What time is it Mr. Wolf?	Soccer baseball (kick/catch)
Clothespin tag	Throw ball in hula hoops (throw)
Fitness tag	Dr. Dodgeball (throw/catch)
Crash	Elimination Dodgeball (throw/catch)
Flip the fish	Hot potato tag (throw/catch)
See ya later alligator	Pass it on tag (throw/catch)
Zumba	Freeze tag (dribble)
Freeze dance	
Zombie tag	
Freeze tag	
Arches tag	

During each session a guided active play approach was used – briefly this involved one kinesiology student as a PA leader. Their role was to follow the scheduled games (about 4-5 per session) and instructed the children on how to play the games and also managed the timing of how long each game is to be played based on what was scheduled. Each session had another group of kinesiology students (~5) to serve as

positive role models and support the skill development without giving specific instructions. Finally one kinesiology student recorded the activities that were played and at what time (time series assessment), which was important for sequencing of accelerometers with the activities; as well as serving as quality control and attendance monitoring.

The comparative group (SAS) had scheduled recreational activity time scheduled from 1-2pm. The sessions were random and divided among physical recreational activities (35%), social skills activities (18%), recreational activities (24%), sport skill activities (18%), and self-improvement skills (6%) – over the course of a week. Table 6 shows a list of the activities that were played during their activity time from 1pm to 2pm. They did not have the guided active play program or any specific motor skill intervention.

Table 6. List of games and activities the children at St. Augustine participated in during their activity time

Comparator Group List of Activities (SAS)
<i>Physical Recreational Activities</i>
Snake's Tail
Dodgeball
Huckle buckle
Ship to shore
Octopus
Freeze dance
<i>Social Activities</i>
Board games
Playing with cards
Parfait making
<i>Recreational Activities</i>
Free time playground play
Heads up (sitting down game)
Movie
Croquet
<i>Sport Skill Activities</i>
Basketball bump
European hand ball
Sitting on floor volleyball
<i>Self-Improvement Activities</i>
Arts and crafts

Assessment of Upper Body Movement

An important aspect of the programming was to determine if the OC (GS2) group was indeed completing more MS related to manipulative skills using upper body movements, such as catching, throwing, striking, etc. Since a simple objective assessment of upper body movement is not readily available in the literature, a pilot study was conducted to determine the feasibility of using multiple accelerometers placed at three different body sites (waist, wrist, and ankle) to assess children's upper body movements in a group setting. The wrists to ankle ratios were used to examine the upper body contribution to movement. The pilot consisted of the following activities: 1) jump

role on the spot (3min); 2) hopscotch (3min); 3) complete a 3 minute obstacle course; 4) throw a ball straight up into the air and catch it (3min); 5) dribble a basketball (3min); and 6) catch a soccer ball (3min), see Figure 4 for an example of a child completing these tasks. All activities were separated by at least 15 minutes with no fatigue identified between the trials. The vector magnitude (counts/min) from the three different body locations - wrist, hip, and ankle – showed considerable variation when performed from locomotor to object control skills. The object control activities show more counts in the wrist compared to the ankle and hip, whereas the locomotor activities show relatively even activity counts between the wrist, hip, and ankle. To quantify these differences a ratio of activity counts (ACC) between the wrist and ankle (W:A) were used to identify upper body motion associated with manipulative skills.

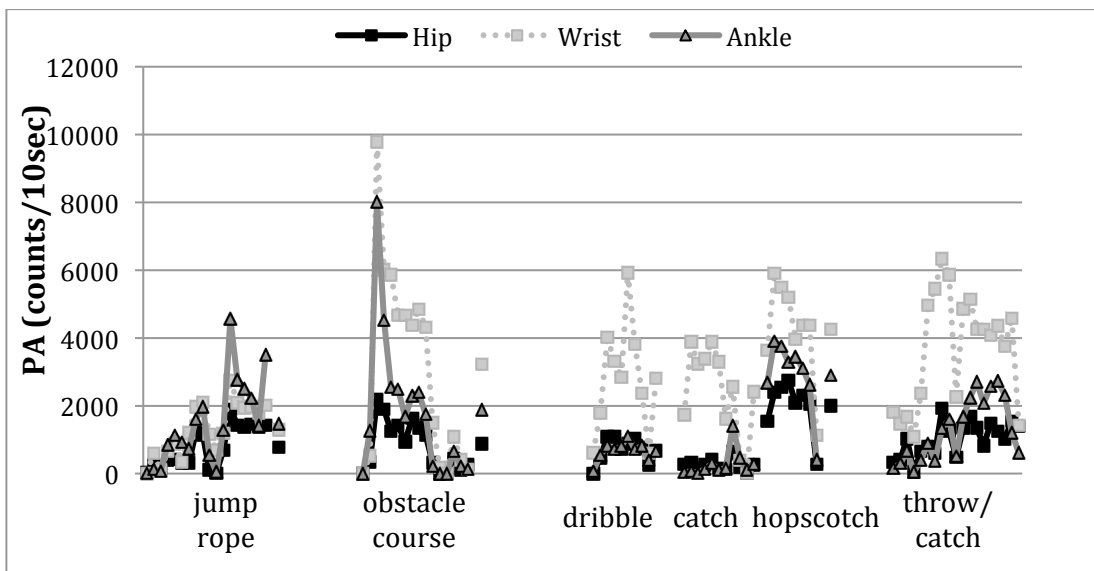


Figure 4. Accelerometric observation for one child of six different activities – 3 focused on locomotor skills (jump rope, obstacle course, hopscotch) and 3 focused on object control skills (dribble, catch, throw/catch) at three body sites; hip/waist, wrist and ankle

The W:A ratios were calculated for children's locomotor tasks (i.e., self-paced jogging, jumping rope, hopscotch, obstacle course) and object control tasks (i.e., throwing the ball in the air and catching it, dribbling and catching (Figure 5a). The average W:A ratio for the locomotor tasks was lower than for object control tasks ($p < 0.05$). In addition to the W:A ratio the METs were also estimated for each task (Figure 5b). The average METs for the locomotor and object control tasks were 7.2 ± 2.6 METs and 3.6 ± 2.2 METs, respectively ($p < 0.05$).

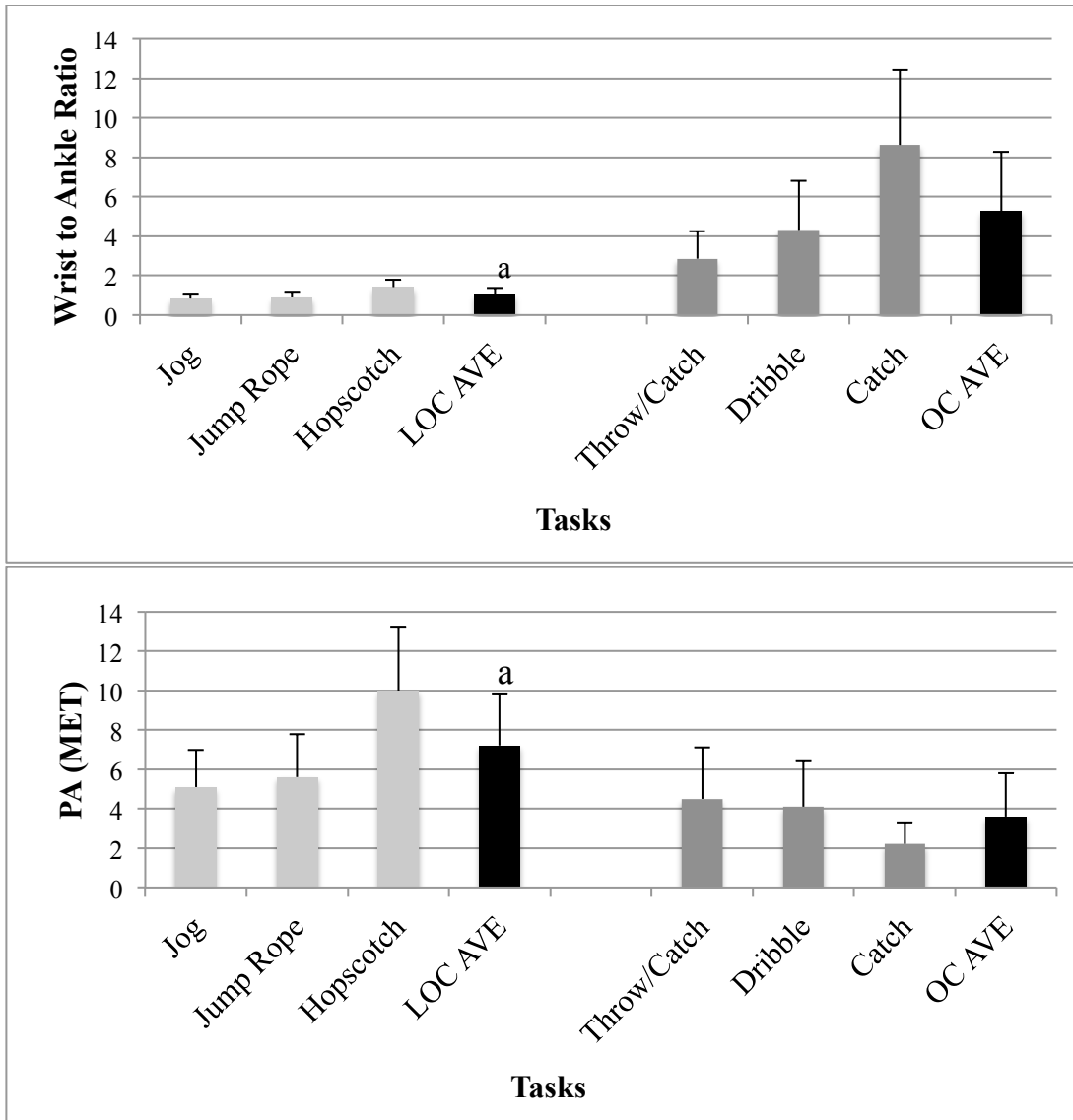


Figure 5. A) Mean and standard deviation of the wrist to ankle ratio of different locomotor and object control tasks (3 minutes each) with a total average (AVE) for four children. B) Mean and standard deviation of physical activity in metabolic equivalents of different locomotor and object control tasks (3 minutes each) with a total average (AVE) for four children

These characteristics of the locomotor and object control skills were not only used to assess upper body movement during the programs, but also supported the development of the GS1 and GS2 intervention programs. It was important to balance the both W:A

ratio and METs for the GS2 group so that they also had an adequate PA component that would also support health and fitness benefits.

Based on some preliminary data collection of the 3-body sites accelerometry, we were able to quantify the proportion of activity in the upper and lower body. This is how the games were organized into each motor skill subset. For example if a higher proportion of activity in the upper body was necessary, then games played included racket balloon. There was no attempt on a progression or activity with the games that will be chosen, there will be no focus on a specific skill each day or each week, in order to prevent a decrease in motivation to participate, the randomness of the games will be implied to keep the children interested and to make sure they will be having fun.

Statistical Analyses:

Descriptive statistics was calculated for all measures and expressed in means and standard deviations (Mean \pm SD). All statistical analyses were conducted using the Statistical Package for Social Science (SPSS) software (version 22.0). The statistical comparisons for the three interventions (GS1; GS2 and SAS) and the two time points (pre-post) was accomplished using a between and within two-way analysis of variance (ANOVA) with repeated measures on the time variable. Statistical significance will be accepted at an alpha level 95% ($p = 0.05$). Tests for homogeneity of the data, effect size and power of the statistical comparisons were also completed. Relationships were assessed using the Pearson Correlation Coefficient (r) for growth and body composition measures with baseline physical activity (kcal/session; kcal/min; MET; MVPA), enjoyment/physical activity attractiveness score and changes in FMS.

Chapter 3: Results

I. Characteristics of Children

The characteristics of the fifty-two children agreeing to participate in this study are found in Table 7. The children assigned to the locomotor (GS1) and object control (GS2) groups were similar. As well, when the intervention groups are compared to the group receiving the traditional summer camp program (SAS) minimal differences were observed ($p>0.05$) (Table 7).

Table 7. Children's physical and psychosocial characteristics prior to participating in the study

	Gosford group 1 (n=17)	Gosford group 2 (n=21)	St. Augustine (n=14)
Age (years)	6.50 ± 1.0	6.48 ± 0.9	6.50 ± 0.7
Weight (kg)	24.67 ± 6.2	26.57 ± 6.6	29.11 ± 8.1
Height (cm)	119.18 ± 6.0	119.91 ± 9.3	126.21 ± 8.9
Body Mass Index (kg·m⁻²)	17.21 ± 3.3	18.35 ± 3.5	18.43 ± 6.2
Leg Power (cm)	17 ± 7.9	16.6 ± 7.6	19.2 ± 4.4
Aerobic Power (ml O₂·kg⁻¹·min⁻¹)	58.64 ± 1.7	59.39 ± 3.1	50.50 ± 5.1
Children's Attraction to Physical Activity	59 ± 7	61 ± 9	55 ± 9
Children's Evaluation of Physical Perception	78 ± 15	81 ± 18	90 ± 9

*. The mean difference is significant at $p<0.05$ for SAS vs. GS1, GS2

II. Upper body Movement: Comparison of Wrist to Ankle Ratios During the Interventions

Using the W:A ratio analysis for both GS1 and GS2 over the 5-wk programs, it was determined that the two group means were statistically different such that the GS2 group have a greater W:A ratio ($p<0.05$) (Table 8). Although a systematic assessment of the

SAS group was not undertaken, a single day assessment at SAS showed a W:A ratio of 1.57 ± 0.42 which is similar to the GS1 group.

Table 8. Total average wrist to ankle ratio between the two intervention groups (50 trials were conducted at each camp, 10 children during 5 sessions)

	GS1	GS2
Wrist to Ankle Ratio	1.52 ± 0.29	1.72 ± 0.26 *

*. The mean difference is significant at $p < 0.05$ for GS1 vs. GS2

When assessed across the 5-wks of the program it was clear that the W:A ratios were consistently higher for the GS2 program (Figure 6); however no statistical difference was noted between the weeks. To identify if the positioning of the three ACC at different body locations influenced the childrens' PA participation (i.e. created an experimental bias), a comparison of the energy expenditures (kcal/min) for both the GS1 and GS2 groups was performed. When the kcal/min were compared across days with and without the three ACC, no difference was observed ($p > 0.05$) (Figure 7).

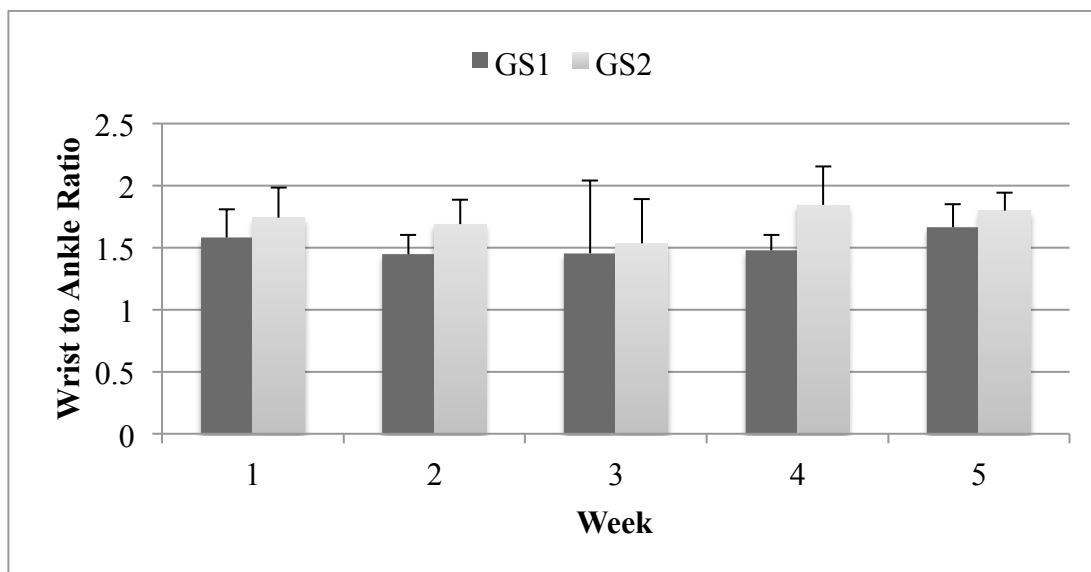


Figure 6. Average wrist to ankle ratio of the two experimental groups (GS1 (n=10 per week) and GS2 (n=10 per week)) for five different sessions over five weeks

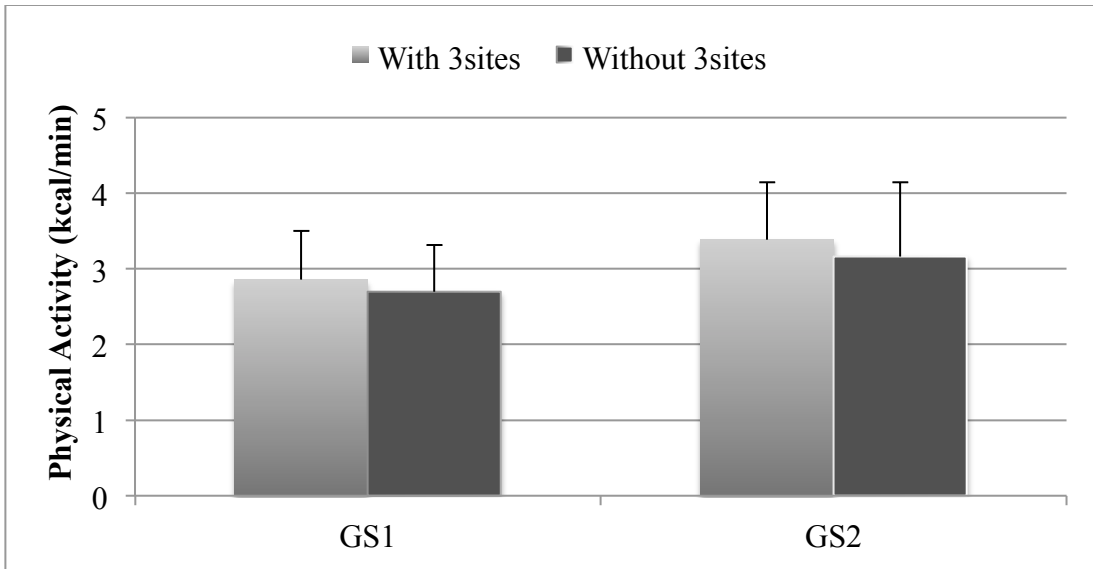


Figure 7. Average wrist to ankle ratio of the locomotor experimental group (GS1) and object control experimental group (GS2) when the 3 sites accelerometry was worn (50 trials were conducted for each group, 10 children over 5 sessions) compared to when the 3 sites were not worn (119 trails were conducted for each group, 17 children over 7 randomly chosen days)

III. Physical Activity Characteristics of the Intervention Programs

The overall assessment of PA during the MS intervention programs is shown in Table 9A. In general children’s physical activity participation for GS1 and GS2 showed similar levels of energy expenditure, % time at MVPA and % sedentary time. Only the energy expenditure per minutes showed a higher level for the GS2 group compared to GS1 group (3.23 ± 0.9 versus 2.75 ± 0.6 kcal/min) ($p < 0.05$). As noted in Table 9B the average energy expenditure per session for the twelve collection days were not different than those observed for all days at GS1 and GS2. Interestingly the kcal/session for either intervention was lower than the kcal/session noted for a cooperative game program (KINKids), which is not specifically focused on enhancing MS proficiency. When comparing PA characteristics with the SAS group, it is apparent that the SAS group had

different participation characteristics than GS1 and GS for energy expenditure per session, % time at MVPA and % sedentary time (Table 9A).

Table 9. A) Mean physical activity data over the camp collection days. B) Mean physical activity data over the intervention days by group and compared to days with KINKids program only without specific MS programming

A)	GS1 (n=15, 111 trials)	GS2 (n=15, 150 trials)	SAS (n=12, 73 trials)
kcal/session	158.8 ± 34.5	170.0 ± 45.0	174.5 ± 38.4 ^a
kcal/minute	2.75 ± 0.6	3.23 ± 0.9 ^b	2.93 ± 0.6
% Sedentary	13.1 ± 4.8	10.2 ± 4.3	36.4 ± 9.8 ^c
% MVPA	47.9 ± 7.8	52.0 ± 14.0	18.4 ± 7.9 ^c

B)	GS1 (n=15, 45 trials)	GS2 (n=15, 45 trials)	KIN Kids (n=34, 68 trials)
kcal/session	157.8 ± 16.5	169.2 ± 19.0	211.3 ± 28.9 ^d

^a. The mean difference is significant at p<0.05 for SAS vs. GS1

^b. The mean difference is significant at p<0.05 for GS1 vs. GS2

^c. The mean difference is significant at p<0.05 for SAS vs. GS1, GS2

^d. The mean difference is significant at p<0.05 for KINKids vs. GS1 and GS2

To determine if the GS1 and GS2 interventions could sustain a consistent level of PA over the program time period, a time analysis for selected days over the 5-wk program are reported. In Figure 8 the kcal/min is expressed over 12 days, which represent the only days when all three groups had common PA data collected (refer to Table 4). Furthermore the days are distributed throughout the 5-wk program; therefore providing insight into the PA characteristics of the programs. Although the group means showed a greater kcal/min for the GS2 group, the time course shows that no one group was different across the twelve days.

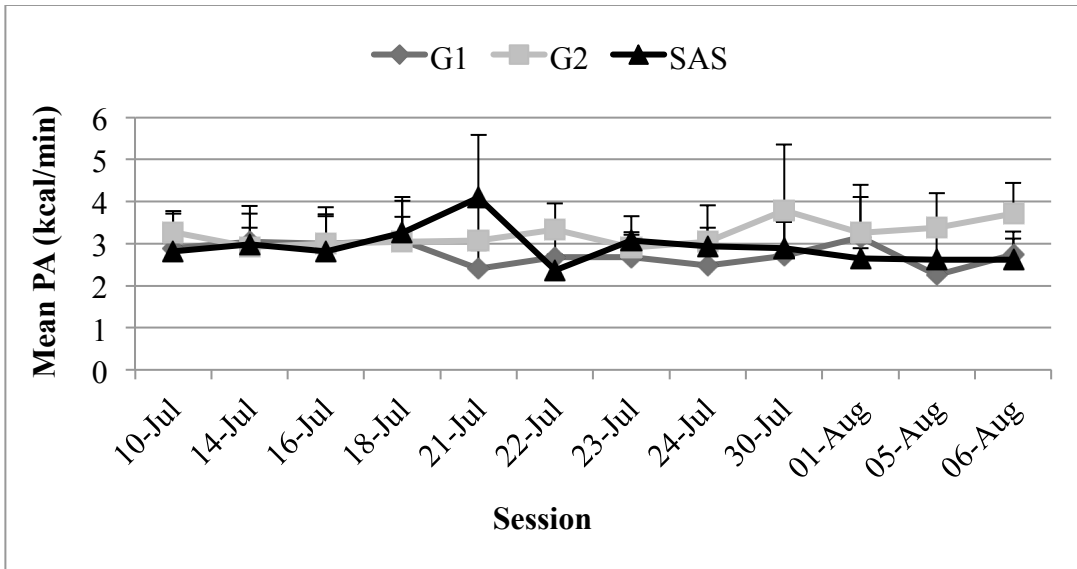


Figure 8. Average kcal/min for all three groups over the length of the program (GS1= 99 trials, GS2=95 trials, SAS=52 trials)

A similar observation was noted for the energy expenditure estimated for each session (kcal/session) across the twelve days (Figure 9).

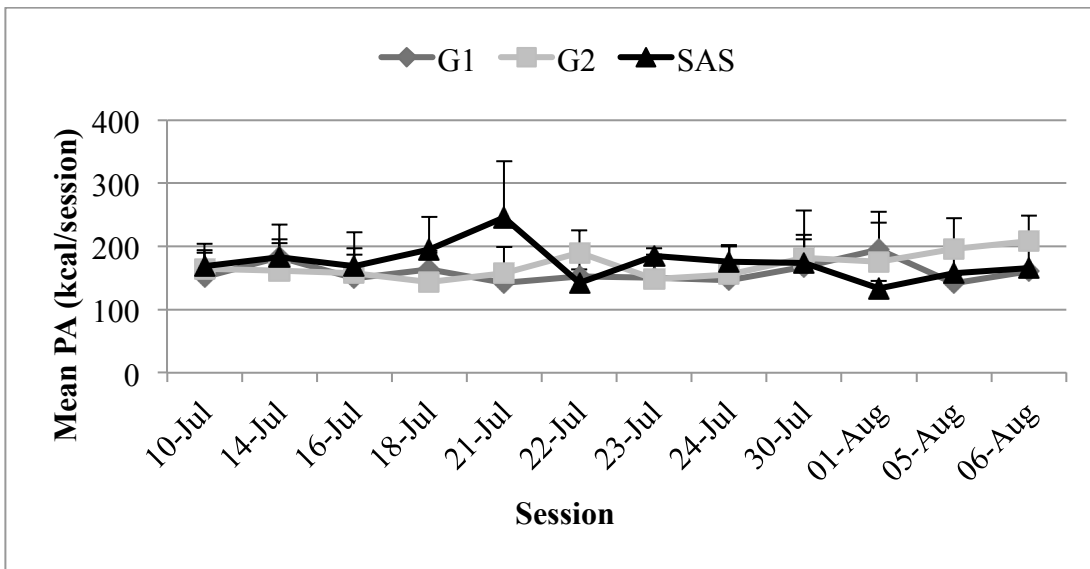


Figure 9. Average kcal per session for the three groups over the length of the program (GS1= 99 trials, GS2=95 trials, SAS=52 trials)

In addition to energy expenditure two other important characteristics are typically used to describe PA programs; these are the percent time spend at moderate to vigorous activity (%MVPA) and percent time spend in sedentary activity (%sed). It is evident that there is more variability for the SAS group over the 5-wks compared to GS1 and GS2. The GS1 and GS2 showed similar %MVPA levels over the program whereas SAS had much more week-to-week variability and was consistently lower to the interventions groups ($p<0.05$) (Figure 10). The %sed time was also different between the intervention groups and the SAS group. The SAS programming had more sedentary time than the GS1 and GS2 groups ($p<0.05$) (Figure 11).

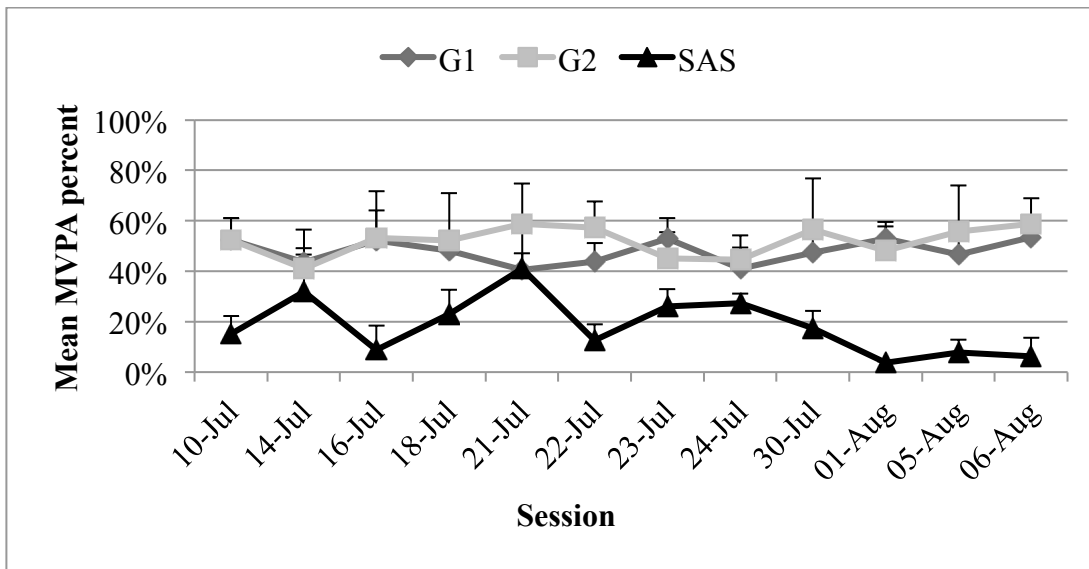


Figure 10. Average percent in time spent in moderate to vigorous physical activity (%MVPA) of the three different groups over the length of the program (GS1= 99 trials, GS2=95 trials, SAS=52 trials)

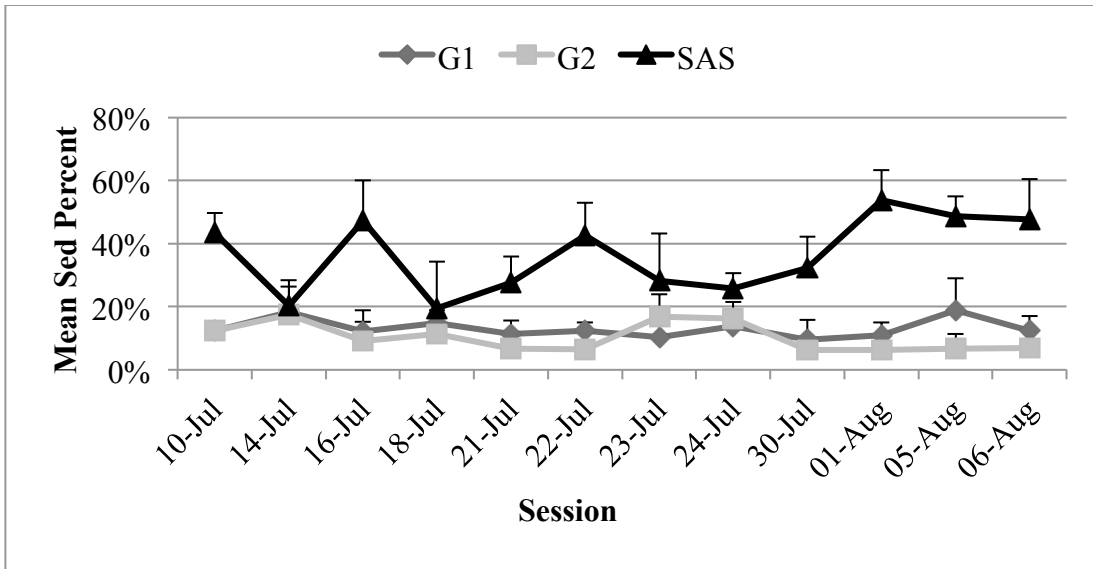


Figure 11. Average percent in sedentary activity time of the three different groups over the length of the program (GS1= 99 trials, GS2=95 trials, SAS=52 trials)

IV. Fundamental Motor Skills

The fundamental motor skill scores for all children prior to the invention programs are reported in Table 10. Generally, there were minimal differences between the GS1 and GS2 groups for all MS assessed. In contrast the MS proficiency for the SAS group was higher than the GS1 group as noted by the GMQ scores ($p < 0.05$). This difference was the result of the LOC sub-type, which was also higher in the SAS group compared to the GS1 group ($p < 0.05$). The OC sub-type was not different for all three groups ($p > 0.05$).

Table 10. The TGMD2 motor skill scores by sub-type (mean \pm standard deviation) for all children at the beginning of the program

	Locomotor Standard Score	Locomotor Percentile	Object Control Standard Score	Object Control Percentile	Gross Motor Quotient Standard Score	Gross Motor Quotient Percentile
GS1 n=15	7.1 \pm 9.2	26.6 \pm 28.2	8.9 \pm 2.6	39.7 \pm 26.7	16.1 \pm 5.3	28.9 \pm 26.7
GS2 n=15	8.3 \pm 2.7	32.9 \pm 27.6	10.5 \pm 3.0	53.40 \pm 26.7	18.8 \pm 4.8	41.3 \pm 28.7
SAS n=12	10.9 \pm 2.9 ^a	58.2 \pm 28.3 ^a	10.2 \pm 2.7	51.8 \pm 28.7	21.1 \pm 4.4 ^a	56.3 \pm 25.3 ^a

^a. The mean difference is significant at $p < 0.05$ for SAS vs. GS1; other comparisons are not significant.

The locomotor intervention program (GS1) had an impact on MS proficiency as evidenced by changes for the MS sub-types and the GMQ ($p < 0.05$) (Figure 12a). The GS2 intervention did not result in any changes to the GMQ nor the OC MS ($p > 0.05$); however the LOCile sub-type did show an improvement after the 5-wks ($p < 0.05$) (Figure 12b). In regard to the comparator group (SAS) no changes in MS proficiency was observed (Figure 12c).

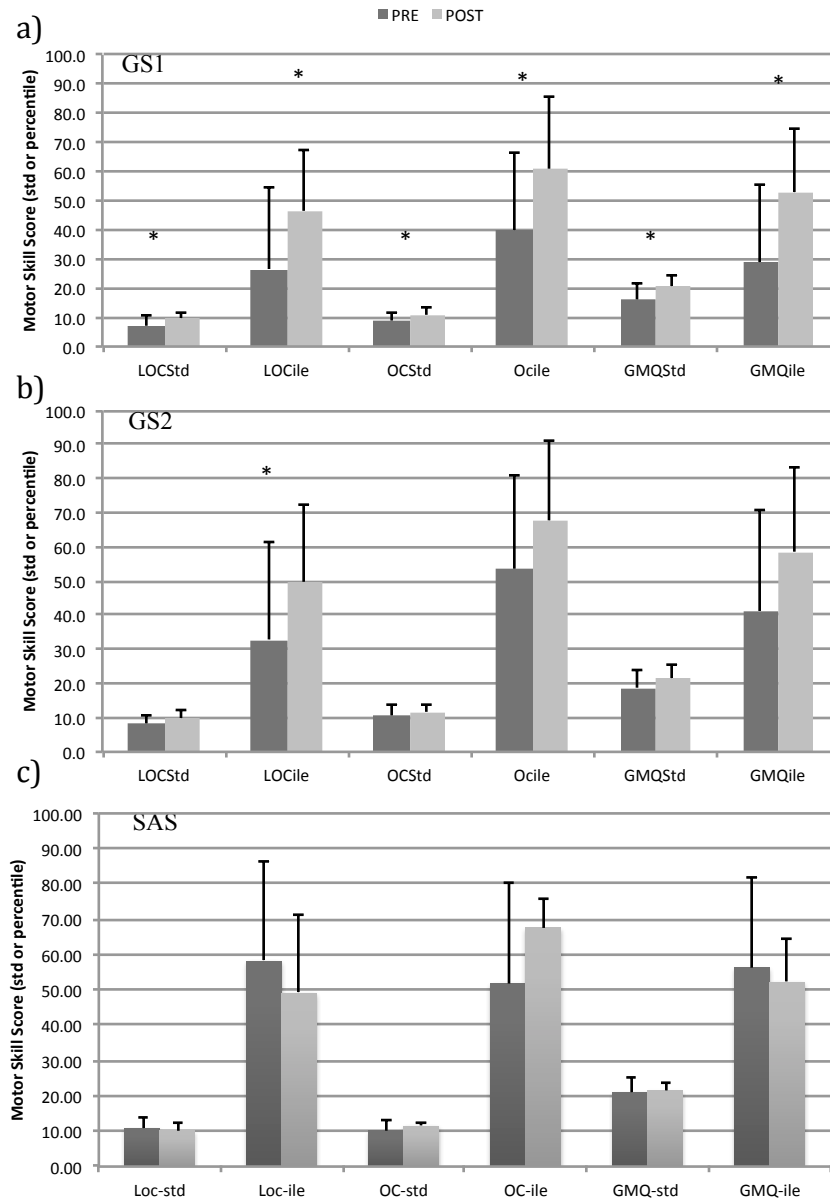


Figure 12. Changes in motor skills following a 5-wk intervention program focused on LOC skills (GS1, n =15), OC skills (GS2, n=15) with a comparator group involved in recreational activities (SAS, n=12) *The mean difference is significant at $p < 0.05$ for pre vs. post

When the MS scores by program are separated into boys and girls, some differences were observed in regard to starting levels of MS proficiency and the magnitude of the change in MS sub-type score as a result of the program delivered. For GS1 it is

clear that the group changes noted in Figure 12 are attributable to the boys with very little change observed for the girls (Figure 13).

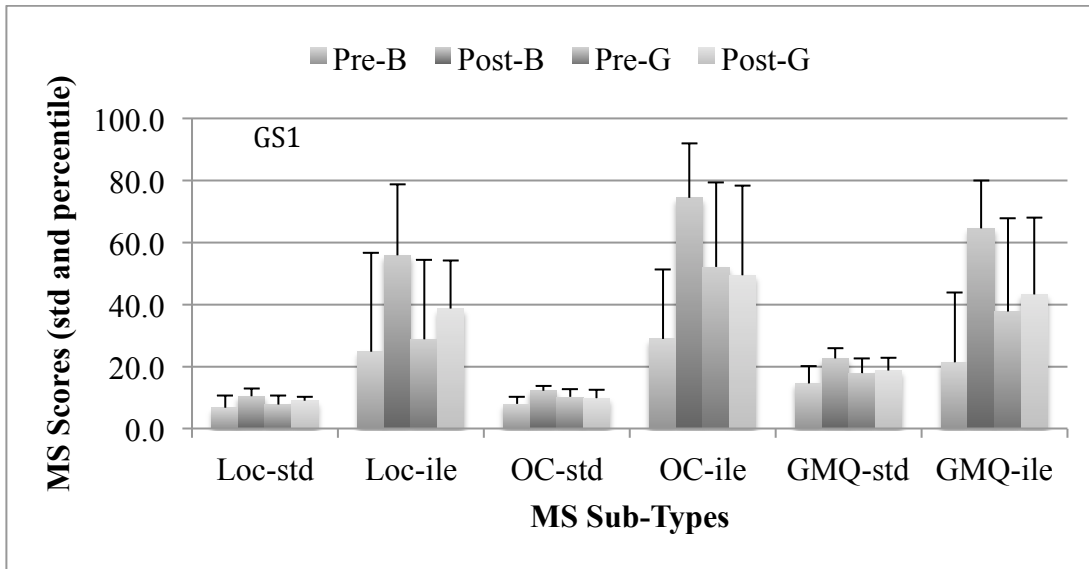


Figure 13. Changes in motor skill following a 5-wk locomotor focused intervention program for the boys (B) and the girls (G) at GS1 (n=15)

The relatively small program changes noted for the MS sub-types for the GS2 group showed minimal boy and girl differences (Figure 14). The LOCile change was again attributable to the boys. For the SAS group, there were small program changes noted, and in some cases there were decreases in MS score, the differences between boys and girls were also minimal (Figure 15).

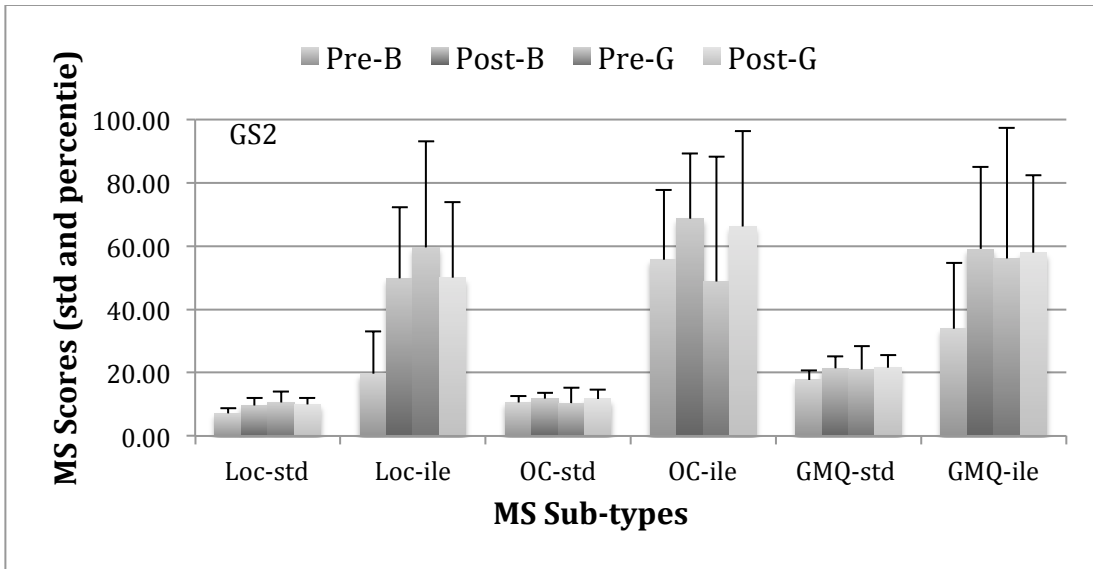


Figure 14. Changes in motor skill following a 5-wk object control focused intervention program for the boys (B) and the girls (G) at GS2 (n=15)

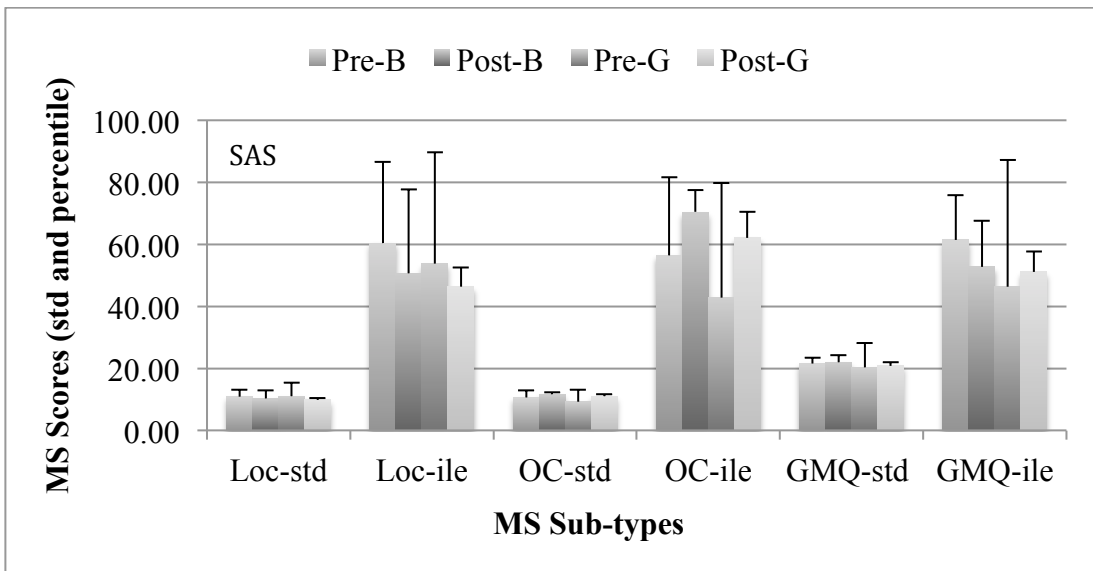


Figure 15. Changes in motor skill following a 5-wk regular camp program involved in recreational activities for the boys (B) and the girls (G) at SAS (n=12)

The mean change for each sub-type of motor skill and overall gross motor quotient scores before the program and after the program is shown in Table 11. There is a significant difference for locomotor standard score between the change seen at GS1 and

the change at SAS. There was no significant difference between the changes across the three groups for the locomotor percentile, object control standard score and percentile, gross motor quotient, and gross motor quotient percentile.

Table 11. Mean change in motor skill before and after the program at each camp

	LOC Std	LOC ile	OC Std	OC ile	GMQ Std	GMQ ile
GS1 (n=15)	2.4 ± 3.6	20.0 ± 30.4	2.0 ± 2.9	21.2 ± 29.9	4.4 ± 5.8	24.1 ± 29.6
GS2 (n=15)	1.5 ± 2.9	16.9 ± 30.9	1.2 ± 4.1	14.4 ± 40.6	2.6 ± 6.3	17.4 ± 40.3
SAS (n=12)	-0.8 ± 3.6 ^a	-9.0 ± 36.8	1.3 ± 2.6	15.7 ± 26.2	0.5 ± 4.3	-4.2 ± 30.3

^a. The mean difference is significant at $p < 0.05$ for SAS vs. GS1

V. Assessment of Factors Influencing Motor Skill Changes

An analysis was undertaken to better understand the impact and relationship(s) among factors proposed to interact with motor skill development (see section Factors Impacting FMS). These factors include chronological age and MS-age equivalencies, parameters, growth parameters (body mass, height, and BMI), fitness parameters (leg power, aerobic power), and psychosocial parameters (perception of physical abilities and attractiveness to PA or enjoyment).

Age and MS-Age Equivalence

The Test of Gross Motor Development 2 identifies age equivalents based on the scores attained for sub-type of MS (locomotor and object control). A comparison of the actual age versus the age equivalencies for both locomotor skill ability (LOC-age) and object control ability (OC-age) at the start of the programs are presented in Figure 16. Consistent with minimal differences in chronological age for the intervention groups, no significant differences were observed for the LOC- and OC-age ($p > 0.05$) at the start of the two intervention programs. A similar observation was noted for the SAS group,

except for the LOC-age equivalency, which was 92 months compared to the 63 and 66 months estimated for GS1 and GS2 groups, respectively ($p < 0.05$).

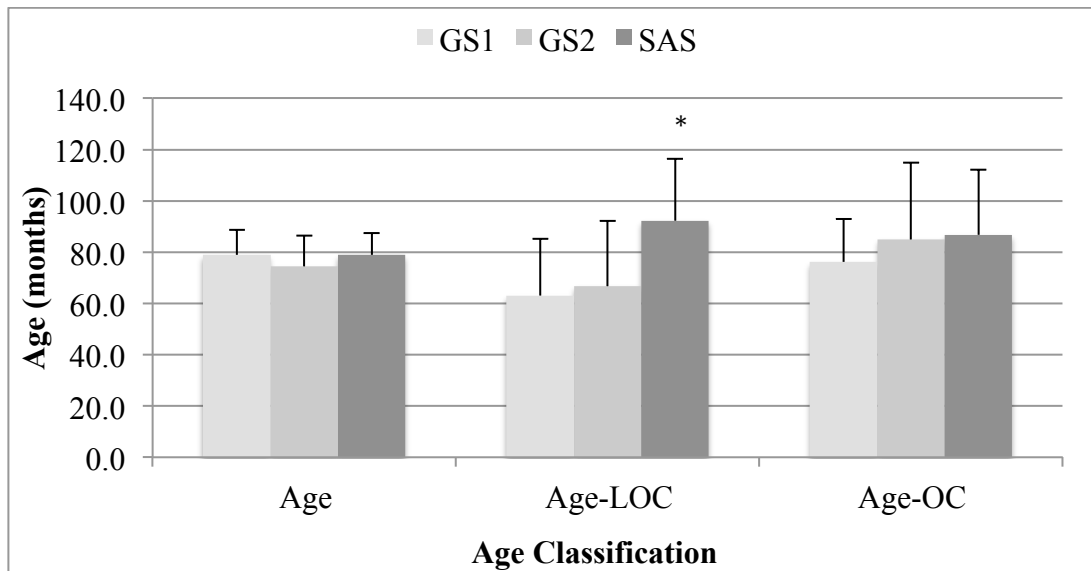
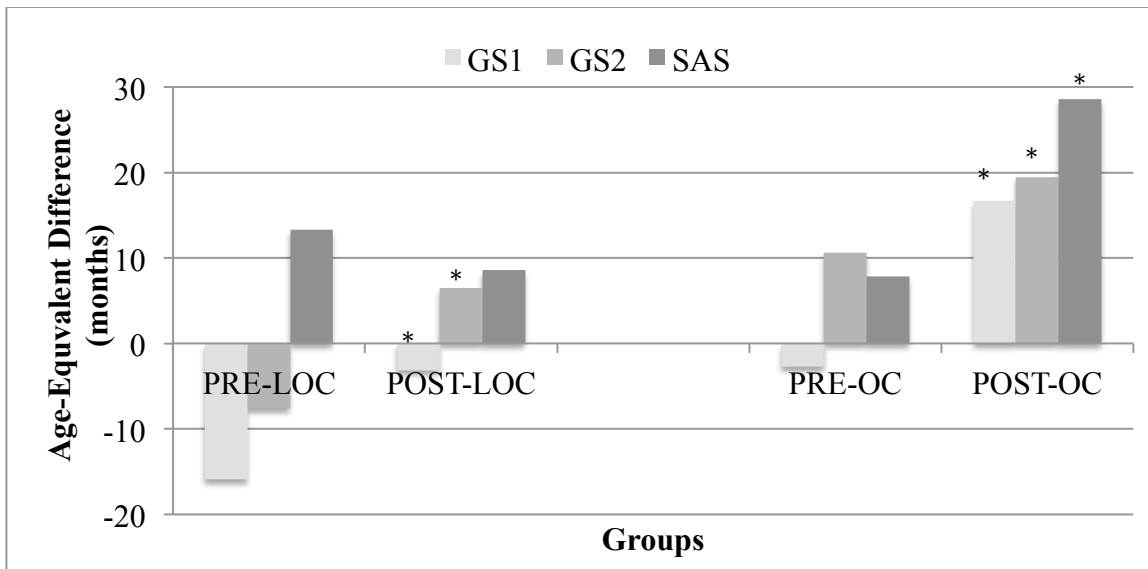


Figure 16. Age and age equivalents of locomotor and object control in months for each group *The mean difference is significant at $p < 0.05$ for SAS ($n = 12$) vs. GS1 ($n = 15$) and GS2 ($n = 15$)

An assessment of the change from chronological age to LOC- and OC-age equivalencies was undertaken to determine if the GS1 and/or the GS2 interventions impacted the change in MS age equivalencies. The GS1 and GS2 groups both increased their LOC-age equivalence by 13 and 14 months ($p < 0.05$); whereas the SAS group showed a slight decrease in LOC-age at the end of the 5-wks ($p > 0.05$) (Figure 17). When the change in OC-age equivalents before and after the program were considered, all groups showed an increase ranging from 8 to 28 months ($p < 0.05$).



	LOCOMOTOR		OBJECT CONTROL	
	PRE	POST	PRE	POST
GS1 (n=15)	-16 ± 24	-3 ± 17*	-3 ± 20	17 ± 27*
GS2 (n=15)	-8 ± 21	6 ± 30*	11 ± 23	19 ± 19*
SAS (n=12)	13 ± 27	9 ± 26*	8 ± 22	29 ± 18*

Figure 17. Change in age equivalents of locomotor and object control before and after the program for each program *the mean age-equivalent difference is significant at $p < 0.05$ for PRE versus POST

Whether or not the improvements in LOC- and OC-age equivalencies were related to individual pre-post changes scores for each sub-types of MS was assessed. The analysis revealed a positive significant relationship between increase in LOC-age and LOCstd for the GS1 and SAS groups ($p < 0.05$) (Table12), but not for any other MS sub-type. In regard to the OC-age changes the coefficients determined for pre-post differences OC-age equivalencies and any MS sub-type were not related ($p > 0.05$) (Table 12).

Table 12. Correlations table of the change in MS parameters from pre to post and the change in actual birth age and MS adjusted age for all camps

		Δ in Locomotor Standard Score	Δ in Locomotor Percentile	Δ in Object Control Standard Score	Δ in Object Control Percentile	Δ in Gross Motor Quotient	Δ in Gross Motor Quotient Percentile
Δ in Locomotor Age	GS1 (n=15)	0.532*	0.444	0.126	0.103	0.388	0.323
	GS2 (n=15)	0.427	0.444	0.215	0.167	0.357	0.337
	SAS (n=12)	0.634*	0.640*	0.27	-0.034	0.508	0.169
Δ in Object Control Age	GS1 (n=15)	-0.116	-0.248	-0.221	-0.245	-0.198	-0.289
	GS2 (n=15)	0.403	0.432	0.407	0.444	0.456	0.482
	SAS (n=15)	-0.508	-0.485	-0.150	-0.155	-0.527	-0.336

*. The mean age-equivalent difference is significant at $p < 0.05$

Growth Parameters and MS Changes

To further understand the changes recorded for MS proficiency within this study, Pearson correlation coefficients between growth variables and the pre-post differences in MS scores was undertaken. In general the analysis showed minimal relationships (r) between body mass, height, and BMI with the changes in sub-types of MS for the GS1 and GS2 groups (Tables 13a, 13b, and 13c). In general similar relationships were noted for the SAS group with a few exceptions, where moderate to good relationships (0.4 to 0.70) were observed between these body mass, height and BMI and select MS sub-types, OCile, LOCile, and OCstd and OCile, respectively ($p < 0.05$). The correlation between leg power and the MS parameters (see Table 13d) showed significant relationships for the GS2 group and pre OCstd score, OCile, GMQstd and GMQile, with very little relationships evident for the GS1 group ($p > 0.05$). Positive relationships ($p < 0.05$) between aerobic power (VO_2 in $mlO_2 \cdot kg^{-1} \cdot min^{-1}$) and the changes in MS sub-types were observed for all three groups and most MS sub-types (Table 13e). Specifically moderate to good

Pearson coefficients were identified for post LOCstd score ($r=0.57$), GMQstd score ($r=0.59$) and GMQile ($r=0.54$) ($p<0.05$) for the GS1 group. Similar relationships were noted for the GS2 and SAS groups (see Table 13e).

Table 13a. Correlations table of body mass and the fundamental motor skill scores before and after the program

		Weight		
		GS1 (n=15)	GS2 (n=15)	SAS (n=12)
PRE	Locomotor Standard Score	-0.172	0.283	-0.142
	Locomotor Percentile	-0.332	0.303	-0.121
POST	Locomotor Standard Score	-0.002	-0.135	0.139
	Locomotor Percentile	0.081	-0.041	0.159
PRE	Object Control Standard Score	0.064	0.063	-0.246
	Object Control Percentile	0.029	0.003	-0.283
POST	Object Control Standard Score	-0.211	0.077	-0.499
	Object Control Percentile	-0.212	0.033	-0.649*
PRE	Gross Motor Quotient	-0.79	0.198	-0.245
	Gross Motor Quotient Percentile	-0.245	0.152	-0.347
POST	Gross Motor Quotient	-0.086	-0.058	-0.116
	Gross Motor Quotient Percentile	-0.152	-0.082	0.132

*. The correlation is significant at $p<0.05$

Table 13b. Correlations table of height and the fundamental motor skill scores before and after the program

		Height		
		GS1 (n=15)	GS2 (n=15)	SAS (n=12)
PRE	Locomotor Standard Score	-0.237	0.564	0.7*
	Locomotor Percentile	-0.447	0.47	0.645*
POST	Locomotor Standard Score	0.03	0.246	0.197
	Locomotor Percentile	0.072	0.285	0.213
PRE	Object Control Standard Score	0.021	0.44	0.175
	Object Control Percentile	-0.006	0.322	0.206
POST	Object Control Standard Score	-0.329	0.275	0.356
	Object Control Percentile	-0.336	0.185	0.405
PRE	Gross Motor Quotient	-0.141	0.534*	0.566
	Gross Motor Quotient Percentile	-0.322	0.452	0.515
POST	Gross Motor Quotient	-0.143	0.236	0.366
	Gross Motor Quotient Percentile	-0.225	0.24	0.329

*. The correlation is significant at $p < 0.05$

Table 13c. Correlations table of BMI and the fundamental motor skill scores before and after the program

		BMI		
		GS1 (n=15)	GS2 (n=15)	SAS (n=12)
PRE	Locomotor Standard Score	-0.136	0.065	-0.401
	Locomotor Percentile	-0.255	0.087	-0.442
POST	Locomotor Standard Score	0.01	-0.347	0.003
	Locomotor Percentile	0.113	-0.245	0.009
PRE	Object Control Standard Score	0.063	-0.179	-0.303
	Object Control Percentile	0.029	-0.177	-0.348
POST	Object Control Standard Score	-0.115	-0.094	-0.585*
	Object Control Percentile	-0.115	-0.104	-0.746*
PRE	Gross Motor Quotient	-0.056	-0.075	-0.449
	Gross Motor Quotient Percentile	-0.201	-0.08	-0.522
POST	Gross Motor Quotient	-0.028	-0.251	-0.298
	Gross Motor Quotient Percentile	-0.077	-0.286	-0.067

*. The correlation is significant at $p < 0.05$

Table 13d. Correlations table of leg power and the fundamental motor skill scores before and after the program

		Leg Power (vertical jump)		
		GS1 (n=15)	GS2 (n=15)	SAS (n=12)
PRE	Locomotor Standard Score	0.165	0.245	ND
	Locomotor Percentile	0.07	0.244	ND
POST	Locomotor Standard Score	-0.019	0.024	ND
	Locomotor Percentile	0.02	0.063	ND
PRE	Object Control Standard Score	-0.094	0.737*	ND
	Object Control Percentile	-0.109	0.654*	ND
POST	Object Control Standard Score	-0.208	-0.17	ND
	Object Control Percentile	-0.225	-0.202	ND
PRE	Gross Motor Quotient	0.06	0.595*	ND
	Gross Motor Quotient Percentile	-0.003	0.566*	ND
POST	Gross Motor Quotient	-0.185	-0.097	ND
	Gross Motor Quotient Percentile	-0.149	-0.104	ND

*. The correlation is significant at $p < 0.05$

ND. The values were not determined

Table 13e. Correlations table of aerobic power and the fundamental motor skill scores before and after the program

		VO₂		
		GS1 (n=15)	GS2 (n=15)	SAS (n=12)
PRE	Locomotor Standard Score	0.008	0.364	0.581*
	Locomotor Percentile	-0.104	0.396	0.501
POST	Locomotor Standard Score	0.573*	-0.014	-0.072
	Locomotor Percentile	0.468	-0.009	-0.072
PRE	Object Control Standard Score	0.544*	0.633*	0.58*
	Object Control Percentile	0.541*	0.511	0.58*
POST	Object Control Standard Score	0.388	0.2	0.202
	Object Control Percentile	0.364	0.133	0.324
PRE	Gross Motor Quotient	0.272	0.597*	0.739*
	Gross Motor Quotient Percentile	0.173	0.572*	0.718*
POST	Gross Motor Quotient	0.549*	0.048	0.084
	Gross Motor Quotient Percentile	0.514*	0.045	0.147

*. The correlation is significant at $p < 0.05$

Psychosocial Parameters and MS Changes

Children's Attractiveness (Enjoyment) to Physical Activity - the children's attractiveness to physical activity (enjoyment) survey measured at the start of the program showed the three groups to be similar, with scores of $59 \pm 7\%$ (GS1), $61 \pm 9\%$ (for GS2) and $55 \pm 9\%$ (SAS) (see Table 7). When considering all groups the relationships (Pearson r) for children's initial physical activity attractiveness scores and the change in MS sub-types ranged from 0.03 to 0.19 ($p > 0.05$). When comparing the coefficients by group; the attractiveness/enjoyment scores versus the absolute change ($\Delta = \text{post-pre}$) for the MS sub-types showed poor relationships for GS2 and SAS ($p > 0.05$) (data not shown). So their attractiveness to PA did not impact their MS scores as a result of their participation in the GS2 and SAS programs. In contrast the GS1 group's initial attractiveness score was related to increases for LOC-std (increased by 3.4%) and GMQ-ile (an increase of 34.9%) ($p < 0.05$).

Children's Perception of Their Physical Functioning/Abilities - The children's perception of self-physical functioning between the three groups was not different (see Table 7). When comparing children's perception of physical functioning versus the change ($\Delta = \text{post-pre}$) for each of the MS sub-types there were minimal differences for the three groups ($p > 0.05$) (data not shown). The relationships (Pearson r) for children's perception of physical functioning and the change in MS sub-types were -0.25 for LOCstd, -0.27 for LOCile, -0.21 for OCstd, -0.22 for OCile, -0.26 for GMQstd ($p > 0.05$). In contrast, the children's perception of physical functioning and their change in GMQile ($r = -0.36$) ($p < 0.05$).

Chapter 4: Discussion

The purpose of this study was to determine the impact of using a guided active play approach during the activity/gym period (1hr) within a community-based recreational program. Specifically two different motor skill intervention programs, one focused on LOC activities (GS1) and the other on OC activities (GS2), were delivered to two different groups of children (5-7yrs) participating in the same community camp. Children's motor skill proficiency assessed for LOC, OC and GMQ scores and physical activity characteristics were measured before and after 5-wks of MS interventions. The primary finding was that improvements in MS proficiency for the GS1 group were observed for all sub-types (LOC, OC and GMQ); whereas for the GS2 group only the LOC score was improved. Minimal changes for MS scores were observed for the comparator group (SAS) that had no specific programming other than a recreational sport-style skills program during their activity/gym time. It was generally observed that MS changes for GS1 and GS2 programs were associated with more time spent in moderate-to-vigorous (%MVPA) and with less time spent in sedentary activity (%sed) during the physically active periods compared to recreational sport-style skills program (SAS). Changes in MS sub-types were not related to estimates of energy expenditures since all three groups had similar levels of kcal/session and kcal/min averaged over the program. In summary the intensity (%MVPA) and type of recreational activity (physically active activities), and not total energy expenditure, are important elements in improving MS proficiency for children (5-7years) attending a community camp program.

To understand the influence of age on individual responses to the interventions, an evaluation of the relationships among chronological age, LOC- and OC-age equivalences

versus the differences in individual responses for MS sub-types was compared at the start of the study and end of the study. When the age differences (months) between chronological age and LOC- and OC-age equivalences were assessed for GS1 and GS2, both age equivalencies were observed to be higher following the programs. Only the OC-age equivalency improved in the comparator group (SAS). When comparing the individual responses for pre-post MS change scores to growth parameters (i.e., body mass, height, BMI), and fitness (i.e., leg power and aerobic power), only aerobic power had a positive relationship to improvements in all MS sub-types, that is LOC, OC and GMQ scores. Psychosocial parameters (i.e., the attractiveness (enjoyment) to physical activity and perception of their own physical functioning) showed mixed results when compared across the two interventions and comparator groups. The improvements in GMQ motor scores for GS1 were associated to the children's scores on the attractiveness (enjoyment) to physical activity scale; which was not evident for the GS2 and/or SAS groups. Whether this relationship was attributed to the specific locomotor games within the LOC program is uncertain and requires further investigation. Finally, the children's perception of their own physical functioning and their change in GMQ percentile showed a moderate to good negative relationship, which suggests that children with a lower perception of their physical abilities can improve their MS proficiency in guided active play programs focused on MS interventions. In conclusion, the findings of this study partially support the hypothesis that PA drives MS changes in children (5-7years); however the nature/intensity of the PA is as or more important than the amount or volume of PA (kcal/session or kcal/min) during children's active play programs.

Physical Activity and Motor Skill Proficiency

The children's MS proficiency scores noted for all sub-types in this study agree with a previous report for Canadian children (5-7yrs). As well, the observation that boys in the current study had greater MS proficiency than girls also follows normal trends for children 5-7 years of age (Temple et al, 2015). Several reports show that MS development is not pre-determined, and that either increases and/or decreases are evidenced during childhood and adolescents. For children without physical- or neuro-developmental challenges the extent of the MS sub-type changes may be quite large and occur over several months/years (6 weeks to 3 years) when participating in MS interventions (Bakhtiari et al, 2011; Cliff et al, 2011; Karabourniotis et al, 2002; Martin et al, 2009; Mitchell et al, 2013). That MS proficiency can be altered through intervention programs is well recognized; however the extent to which PA (energy expenditure and/or intensity) can promote improvements remains uncertain. Despite Stodden and colleagues' (2008) suggestion that a reciprocal relationship exists between PA and motor competence during early/middle childhood; the acceptance/adoption of this hypothesis remains controversial. Clearly further evidence is warranted on the relationship between PA levels and changes in MS proficiency for specific intervention programs.

PA levels (assessed by pedometers (i.e., step counts)) have been reported not to change and/or showed lower levels following MS programming/training. For example an 18-wk intervention (4 days a week for 15-20mins), which focused on multiple MS activities (running, hopping, skipping, trunk strength, ball skills) that eventually developed into more complex movement activities showed improvement in MS GMQstd scores without changes in PA levels (Bellows et al, 2013). Moreover, Cliff and colleagues

(2007) designed a 10-wk intervention program to increase PA by using MS activities. The intervention program was 2-3 times per week for 10 weeks (total of 20hours). The results showed an average increase for GMQ scores (assessed using the TGMD-2), but a 14% decrease in PA levels after 10-wks (using the MTI 7164 ActiGraph accelerometer). From these reports it seems that there may be a “trade-off” when planning MS interventions between the time spent on specific MS tasks and the amount of time spent in PA participation; where increases in MS proficiency occur with minimal PA levels. Although the improvements in MS sub-types may provide some short-term benefit during early/middle childhood, it may be argued that the lower PA participation levels may compromise both MS development later in childhood and the suggested levels of PA required for health and fitness benefits (Colley et al, 2011).

The importance of being physically active to improve MS proficiency for longer-term benefits has been proposed. Briefly it was suggested that a positive reciprocal relationship between PA and MS proficiency exists during childhood (Stodden, 2008). Despite the reports showing increases in MS proficiency with limited or reduced PA levels, the questions remains: a) could increases in MS proficiency occur while maintaining higher levels of PA; and b) are changes in MS sub-types specific to MS programming? Answers to these questions are necessary if the relationship between PA and MS changes are to be validated. In the current study the changes observed for MS sub-types showed increases in GMQ (std and percentile), OC (std and percentile), and LOC (std and percentile) for GS1 ($p < 0.05$). Limited increases were observed for GS2 with only LOC percentile scores being higher after the intervention program ($p < 0.05$). In contrast minimal pre-post changes were noted in the comparative group (SAS) ($p > 0.05$).

When these MS results are viewed in relation to PA levels interesting outcomes were noted. In regard to PA levels, expressed as kilocalories per minute, the overall program PA average for GS1 was lower than GS2 ($p < 0.05$) and similar to SAS. When average energy expenditures (kcal/session) were estimated for the GS1 group, again they were lower than the SAS group ($p < 0.05$) and comparable to the GS2 group. These results support the notion that a “trade-off” between MS improvements and lower PA levels is necessary in MS programming. The lower average PA levels measured for the GS1 intervention in light of the improvements noted for GS1 MS sub-types was surprising, since the guided active play games and format have been associated with greater PA participation (West & Shores, 2008; Belcastro et al, 2012). The larger average PA response (~18% increase in kcal/min) for GS2 and the limited MS improvements (only LOCile improved) also suggest that PA levels may not be the primary drivers for improvements in MS sub-types as would be suggested by Stodden and colleagues’ model. When the daily PA levels are viewed across the 5-wks, it is apparent that the week-to-week estimates for kcal/session and kcal/min were consistent; and therefore did not contribute significantly to the differences in the PA group averages. Taken together these results do not support the hypothesis that PA levels, alone, (kcal/session and kcal/min) drive MS improvements in children (5-7yrs). Whether this is the case in long-term community programs requires further investigation. A possible explanation for these observations between PA levels and MS changes may lie in the nature of the interventions – as hypothesized it was expected that the GS1 program would be associated with greater energy expenditures due to the nature of the LOC activities (i.e., increased amount of running). However, in attempting to keep PA activities high in the GS2 group and also

include more OC games, it appears that there was as much energy expenditure involved in this intervention (OC games), despite being delivered with more upper body movements, as evidenced by higher W:A ratios. Another factor that may explain the differences in MS improvements and PA levels, is the observation that children in GS2 had more difficulty in maintaining control of the ball/racket/balloons during OC activities. This necessitated children chasing after them; thereby contributing to the increased energy expenditure for the GS2 group, without contributing to OC and GMQ improvements.

Although measures of energy expenditure (i.e., the kcal/session and kcal/min) showed variable results, it has been suggested that the intensity of PA – moderate to vigorous PA – may be an important factor contributing to changes in MS proficiency during early/middle childhood. Reily and colleagues (2006) conducted a program looking at the relationship between habitual activity and FMS; the results showed percent time spent in MVPA was correlated to movement skill score in preschool children. In regard to moderate-vigorous PA, Williams and colleagues (2009) observed correlation coefficients of 0.33 and 0.41 ($p < 0.05$) between MS performance and percent time in MVPA and VPA, respectively, for young children (~4yrs). The relationship between changes in MS proficiency and the intensity of PA was also identified in the current study, and extended the relationship to school-aged children (5-7yrs). The children in the GS1 and GS2 programs had on average 47.9 ± 7.8 and 52.0 ± 14.0 %MVPA, respectively, compared to the 18.4 ± 7.9 %MVPA for the comparator group. The higher %MVPA ($p < 0.05$) and lower %sed time ($p < 0.05$) for both GS1 and GS2 groups, in contrast to the comparator (SAS) group, suggest that the characteristics of the PA participation are important in driving MS sub-types changes during early/middle childhood. Moreover the

differences in %MVPA for the GS1 and GS2 interventions were maintained between 40-60% MVPA across the 5-wk, while the %sed time remained consistently below 20%. The SAS program showed different patterns in terms of the averages and variability for the %MVPA and %sed time observed. Whether these observations are possible in non-instructional play settings is unknown; however the compendium for PA characteristics for children's activities (i.e., roller skating, jump rope, chasing/tag games, etc) indicates a range from 4-6 METs is possible for recreational activities (Lamonte & Ainsworth, 2001). The physical activity results for the two intervention groups in this study confirm the idea that community camp programming can achieve weekly averages from 3.84 ± 1.03 to 4.56 ± 0.95 METs over the program. In regard to individual children responses these ranged 0.99 to 10.59 MET over the program. Clearly the PA using guided active play approach in a community camp/field setting is within the range shown to elicit improvements in MS proficiency (Belcastro et al, 2015). In addition to being physically active, Ward and colleagues (2010) suggested that children should be participating for at least 30-45min per day, 5-6 days per week (or a range of 2.5 to 4.5 hours/wk) in order to see improvements in MS proficiency. Children in the GS1 and GS2 groups averaged 19 hours over the five weeks or 3.8 hours/wk (228min/wk) of physically active games. In contrast over the same time period the SAS group participated in 1.8hours/wk (108min/wk) of physically active recreational sport skills activities. The results of the current study indicate that the guided active play approach, which is self-paced, can elicit the intensity and duration of physical activity shown to be necessary for driving MS proficiency in children (5-7yrs). This is important since research suggests that school aged children are not meeting the 60 minutes of daily physical activity (Oliver et al, 2007;

Taylor et al, 2009; Okely et al, 2009). It is concluded that the intensity of the PA, and not the amount/volume of PA, is an important factor related to the increases in MS proficiency during early/middle childhood. Whether the changes for intensity of PA and MS sub-type proficiency persists over longer activity programs and/or are causative, requires further investigation. Nonetheless, from the results of this study, it is proposed that the relationship model (Stodden et al, 2008) between PA and MS proficiency may need to be revised to reflect the notion that PA intensity (>40%MVPA) is an important component influencing children's motor skill development.

Factors Influencing Motor Skill Proficiency

Individual responses in this study were varied and an analysis was undertaken to provide an understanding of MS changes for children (5-7yrs). As previously mentioned (see Factors Impacting FMS), several factors have been identified to influence MS proficiency; these include individual physical characteristics and abilities (age, gender, body composition, aerobic endurance), perception of physical abilities, and PA enjoyment.

Age and Gender - the impact of age on the development of MS varies for each of the motor skills (see Age Trends). During development children do not necessarily proceed through the stage in the same sequences of at the same time, therefore individual differences are an important factor to consider (Gallahue, Ozmun & Goodway, 2012). Gender differences are also seen when MS are developing throughout the early childhood period (ages 3 to 7 years). Object control skills are generally seen later in girls, and performance outcomes for other motor skills consistently favours the boys (Robertson &

Konczak, 2001; Butterfield & Loovis, 1993; Butterfield & Loovis, 1998; Thomas & Marzke, 1992; Mckenzie et al, 2002; Morris et al, 1982).

The Test of Gross Motor Development-2 accounts for the age and gender differences when calculating the standard and percentile scores. As well an approximate age equivalent is calculated based on the raw scores. The age equivalent score gives a sense of what age level the child is performing at for each of the subtests (LOC and OC) based on normative trends (Ulrich, 2000), this allows for a comparison between the actual age versus the age adjusted by LOC skill ability and age adjusted by OC ability (see figure 15). When chronological age is compared among the three groups, it is evident that there were no significant differences. However, the LOC age equivalent for the SAS group was significantly higher than GS1 and GS2 ($p < 0.05$), indicating that the SAS group was generally more developed in terms of LOC skills at the start of the program. The changes in age equivalents before and after the program indicate that the SAS group did not improve their LOC age equivalent after the program was delivered, this may be due to the high baseline LOC skill score. A possible reason the SAS group may have only increased in OC and not LOC abilities may be due to the nature of the activities that were played during their activity time. SAS activities included more sport specific types of activities (European handball, soccer, volleyball, basketball bump), which require OC skills. With increased sport specific skills the PA intensity level tends to be compromised, which was seen in the SAS group since they had more sedentary and less MVPA compared to the GS1 and GS2 groups ($p < 0.05$).

Physical attributes - the correlations between the physical measures and the pre-post differences in MS scores showed minimal differences between body mass, height, and

BMI with MS changes for the two intervention groups (GS1 and GS2). This means that these parameters did not have an impact on MS changes, which may mean that the intervention program can show positive improvements regardless of the children's physical attributes. Similar relationships were seen for the SAS group with a few exceptions, body mass, height and BMI for select MS subtypes. The GS2 showed significant relationships between leg power and OC and GMQstd and GMQile. The relationship between aerobic power and MS were positive ($p < 0.05$), specifically the LOCstd showed a significant relationship; this may be due to the fact that the LOC skills (run, jump, hop, leap, etc.) are skills that improve aerobic fitness.

Children's Attractiveness to PA - when comparing the attractiveness scores and the absolute change for the MS minimal differences were observed between GS2 and SAS. This implies that the children's enjoyment of the PA did not interfere with their MS improvements. The GS1 group showed greater changes in LOCstd and GMQile compared to the other two groups. The relationship between the children's PA attractiveness scores and the change MS did not have a significant relationship, this is useful because we know that improvement in MS is not dependent upon the attractiveness to PA, so if a child feels insecure, there is still potential to show improvements in MS regardless of how they feel about PA participation.

Perception of Physical Functioning - the three groups did not show any significant differences between their physical perception of PA and the MS. The relationship between the perception of physical functioning and the MS were not significant, with the exception of the change in GMQile. The Pearson relationships showed a negative

relationship between perception of physical functioning and their change MS, this means that the children's self-competence was not altered by their improvement in MS.

The Nature of the Motor Skill Intervention

Whitlock and colleagues (2002) noted when conducting behavioural related interventions research that reports should contain detail/information on: content/elements, provider, format, setting, recipient, intensity, duration, and fidelity. Davidson and colleagues (2003) analyzed these criteria and reported that behavioural research reports should emphasize the fidelity of the interventions by answering the questions: was the intervention delivered as intended? And how was it monitored and measured? When considering children's PA and/or MS proficiency interventions many reports do not meet the fidelity criteria. For the most part MS interventions are described as running, jumping, throwing, catching etc... without much attempt to identify the fidelity of these activities (Bassett et al, 2014). This should not be interpreted as requiring detailed biomechanical analysis of each child for each program but more of a higher-level gross movement assessment of the intervention. In an attempt to improve the fidelity of the intervention the results of a pilot study (see fig 5a and b) indicated that OC MS have a greater W:A ratio and lower MET requirement compared to LOC MS, which have lower W:A ratio and higher METs. In this study, the W:A ratio was assessed for the two intervention programs which were based on games requiring either LOC skills (GS1) or OC (upper body) skills (GS2) during the guided active play format. The fidelity and adherence to the programs were confirmed through an upper body movement analysis technique using the wrist to ankle accelerometer counts ratio (W:A). Specifically there was a significantly

higher total average W:A for GS2 (1.72 ± 0.26), which had the OC focused program, compared to the LOC program for GS1 (1.52 ± 0.29). The average W:A ratio during the weeks of the program (see figure 10) showed that the GS2 group was consistently higher than the GS1 for each week. Both the GS1 and GS2 guided active play W:A ratios for children's games are above those observed for laboratory based treadmill exercise - a W:A ratio of 1.13 at 8km/h (Kim et al, 2014). From these results it can be determined that children's games when used for MS interventions in a guided active play format are effective in promoting more upper body movement compared to linear running, and with OC games having significantly more upper body movement than LOC games. Whether the W:A ratio difference would be increased and cover the full range of W:A ratio (0.49 to 7.72) if children participated in an intervention just focused on the MS test items is unknown and warrants further investigation. Although the W:A ratio in this study did not cover the full range of possible W:A ratios noticed for simulated tasks, it is questionable if an intervention just focused on the MS test items would elicit sufficient PA to support relevant increases for MS proficiency (due to "trade-off" in the programming). The results of this study provide evidence that higher W:A ratio for the GS2 group did not jeopardize the EE levels required to improve MS proficiency (Temple et al, 2014). The wide range in W:A ratio noticed for the GS1 and GS2, as well as another report (Do Yoon Kim et al, 2014) could be due to the nature of the participation in physical activity (playing games in the gym versus running on a treadmill) and/or the cohorts involved - adults versus children. Finally to identify if wearing three ACC at different sites influenced the children's PA and/or MET responses, a comparison of PA outputs (i.e., average kilocalories per minute) between three-sites and one-site showed minimal

differences. Therefore the results indicate that differences in W:A ratio and/or METs in the current study are not due to changing PA participation as a result of applying more ACC on certain days (i.e., no apparent methodological bias).

Limitations, Issues, and Challenges

Several factors need to be considered when working with children participating in community-based physically active recreation programs. The research setting cannot be tightly controlled (and it could be argued that they should not be) when planning, delivering, monitoring, and evaluating children responses in real world settings. By their nature these field/community-based research studies must be flexible and consider the requirements of the program and the participants. Factors to consider include:

General issues with community based research (Whitley et al, 2014):

- Difficulties in obtaining trust
 - Community partners can be hesitant to trust researchers (Beniot et al, 2005)
 - Concerns with value of the data collection
 - Power relations
- Obtaining parental consent
 - Lack of access to parents due to low parental involvement in underserved communities
 - Language barriers
 - Can be intimidating for some parents to read and sign an official document from the academic community

- Cultural competence – diversity in value and practice of physical activity behaviours
- Attrition
- Scheduling conflicts
 - Needed to work within the camp environment - schedules and rules
 - Length of program: the camps were prescribed for 7 weeks during July and August – longer term programs may achieve different results.
 - Time constraints within a defined structure and program challenges the necessary pre and post assessments that are necessary (i.e., CAPA survey, PedsQL4.0 survey, and the upper body movement assessment (i.e., three ACC analysis).
- Study/experimental design challenges:
 - No ‘true’ control group (comparative group): children registered in a specific camp and could not be moved around or randomized – as a result groups may not be identical with varying physical, motor and psychosocial skills.

Future Directions

- Developing PA programs with increased time spent in MVPA to incorporate into community camp programs, school curriculums, after school programs, etc.
- Impact of a guided active play motor skill intervention program is that increased MVPA will not only elicit improvements in health and fitness parameters but also develop motor skill proficiency, contributing to self-confidence and competence, which will increase PA and sports participation.

- No apparent methodological bias was evident for the three sites ACC due to similar PA when children wore the 3 ACCs compared to when they did not, therefore, an upper body movement analysis technique using the wrist to ankle accelerometer ratio counts is recommended as a way to account for adherence to a MS program without the use of an extensive biomechanical analysis.

Conclusions

The relationship(s) between motor skill competencies and participation in physical activity suggest that during early to middle childhood (3-7years) motor competency is important as it drives participation in physical activity. During late childhood and adolescence the PA then drive MS competency leading to more specialized sport skills and/or activities for an active lifestyle (Stodden et al, 2008). Recently it has been suggested that the Stodden Model is too simplistic and that PA may indeed drive MS proficiency in early-middle childhood (Temple et al, 2014). The results of this study extend the notion that PA drives MS proficiency in early-middle childhood by showing that not only is energy expenditure (~170 kcal/session) important when considering PA requirements for MS changes; but that the intensity of the intervention (i.e. the %MVPA) is also necessary. In this study, improvements in MS proficiency occurred between the range of 40-60% MVPA. Furthermore, the percent sedentary time during the interventions was less than 20%. It is clear that these PA characteristics are not sufficient alone to improve, the nature of the activities must also be considered since GS2 did not improve to the same extent as GS1, despite having similar PA characteristics over the

intervention. Whether these PA characteristics are a necessarily prerequisite for all motor skill changes is uncertain, and requires further investigation.

It is evident from the results of this study that a ‘trade-off approach’ needs to be considered with MS intervention programming, such that PA with higher EE is associated with less MS improvements and/or greater MS improvements are associated with PA with lower energy expenditures. A possible explanation for improved MS with EE PA may be due to the nature of the delivery for MS programs. For example with MS programs more instruction time, practice time (drills) and scrimmages/games are included. This involves children lining up and waiting for their turn to play and children with poorer MS sitting out some of the time. This is an issue because the main goal of increasing MS proficiency is to contribute to increased PA participation and the increased time at moderate-to-vigorous PA. This study reveals that the locomotor focused guided active play intervention program can not only increase MS proficiency in both locomotor, object control, and overall gross motor skills but the program was also able to maintain an increased amount of time spent in moderate to vigorous intensity levels and decrease sedentary time, thereby contributing to the children’s health and fitness.

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APPENDIX A: Abbreviations

ACC	Accelerometry
ANOVA	Analysis of variance
AVE	Average
B	Boys
BMI	Body mass index
BOTMP	Bruininks-Oseretsky test of Motor Proficiency
CAPA	Children's Attractiveness to Physical Activity
EE	Energy expenditure
FMS	Fundamental motor skills
G	Girls
GMQ	Gross motor quotient
GMQile	GMQ percentile
GS	Gosford
GS1	Gosford locomotor group
GS2	Gosford object control group
KTK	Körperkoordinationstest für Kinder
LOC	Locomotor
LOC-age	Locomotor age equivalency
LOCile	Locomotor percentile
LTAD	Long-Term Athlete Development
METs	Metabolic equivalents
MMT	Maastrichtse Motoriek Test
MOT 4-6	Motoriktest für Vier- bis Sechsjährige Kinder
Movement-ABC	Movement Assessment Battery for Children
MS	Motor skill
MVPA	Moderate- to- vigorous physical activity
O2	Oxygen
OC	Object control
OC-age	Object control age equivalency
Ocile	Object control percentile
PA	Physical activity
PDMS	Peabody Development Scales
PedsQL	Pediatric quality of life inventory
r	Pearson correlation
SAS	St. Augustine
SD	Standard deviations
SPSS	Statistical Package for Social Science
Std	Standard score
TGMD	Test of Gross Motor Development
TGMD2	Test of Gross Motor Development 2

VO ₂	Oxygen consumption
W:A	Wrist-to-ankle ratio
Wk	Week
%MVPA	Percent time spent in moderate-to vigorous physical activity
%Sed	Percent time spent in sedentary activity
Δ	Change

APPENDIX B: Gosford Activity Observations

Monday June 30, 2014 (full day)

9:10 am –playing in the classroom/colouring/playing board games/lego

9:45 am- started to put away the games

9:50 am- finished putting away the games

9:50 am – sat down on the carpet to listen to the staff instructions for the next activity

9:55 am- all kids went to wash their hands

9:56 am- snacks time

10:07 am –end snack time

10:07 am- kids sat on the carpet and listen to instruction for next activity.

10:10 am –walk to the gym

10:14am- start name game (kin kids)

10:27 am –end name game

10:27am – start cat/mouse game

10:31 am – end cat/mouse game

10:31 am-sat in the middle/listen to new instruction for new game “what time is it Mr Wolf”

10:32 am-pick a new Mr wolf

10:43 am- end “what time is it Mr wolf”

10:43 am- sat in the middle for instructions for a new game “Octopus”

10:45 am- start octopus game

10:50 am- pick a new octopus and continued to play octopus

10:53 am-end octopus game

10:53 am –water break

10:55 am –return from water break/sat in the middle/instructions for new game
“Crocodile”

10:56 am –start crocodile game

11:04 am-end crocodile game

11:04 am –sat in the middle and instruction for new game “Blob tag”

11:06 am-start blob tag game

11:10 am –water break /end blob tag game

11:12 am-return from water break/sat in the middle and instruction for new game “crash”

11:14am-start crash game

11:20 am –end crash game/ sat in the middle/ kid chose a new game “freeze tag” and
explained the rule for freeze tag game

11:22 am-start freeze tag game

11:25 am –end freeze tag game/Kin kids program ended

11:25 am –line up to return to class

11:30 am-took a nap

11:43 am- end nap

11:43 am –show and share game (kid showed their drawing to their classmates and talk
about what they dreamt during their nap time)

11:50 am –end show and share game

11:50 am –start playing catch and throw ball in class

11:55 am-end catch and throw ball game

11:55am - kids wash their hand

12:00pm- lunch time

12:20 pm- end lunch

12:20 pm-played games (lego/colouring/boardgame)

1:02 pm-stop game (lego/colouring/board game) and started to put away the games

1:05 pm –stop cleaning up

1:05 pm –art and craft time (colouring)

1:45 pm-end art and craft time

1:45 pm-clean up (put away crayon and marker)

1:50pm- sat on the carpet and present their drawing to their peers

1:55 pm-all kids finish showing their drawing and started to play “Simon says”

2:00pm-stop “playing simon says” and then wash their hands

2:05pm -finished washing their hands

2:05pm –snack time

2:16pm-end snack time

2:16pm -sat on the carpet

2:18pm-line up to play outside

2:20pm –played outside (some played with soccer ball or hula hoop)

2:54 pm-stop playing outside and walk back to class

2:56pm-water break

2:59 pm-finish water break

2:59pm – line up and walk to the gym

3:00 pm-sat in the middle and played a throwing ball game

3:05 pm-ended the throwing ball game

3:05pm-started a new game called “fast food”

3:12pm-stop playing fast food

3:12pm –start new game octopus

3:15pm-end octopus game/water break

3:17pm-return back from water break and continued to play octopus

3:19pm -stop playing octopus

3:19pm-started to play a new game called “board line”

3:24pm-stop playing “board line”

3:24pm-started to play a new game “freeze tag”

3:27pm-stop playing freeze tag/kids line up to return to classroom and water break

3:30pm- took off their accelerometer

Wednesday July 02, 2014 (full day)

9:18 am- kids began to play Lego/board game/colouring

9:46 am- clean up time (put away the Lego, board game and crayons)

9:49 am-finished cleaning and sat on the carpet /kids introduced themselves to their peers

9:55 am-kids finish introducing themselves to their peers and then wash their hands

10:01 am- finish washing their hands

10:02 am- snack time

10:10 am-end snack time

10:10 am-line up to go to the gym

10:15am-walk to the gym

10:20am-start kin kids with stretches

10:24 am-stop stretching

10:24 am- instruction for new game “arch tag”

10:25 am –start arch tag

10:32 am-end arch tag game

10:32am-sat down in the middle /instructions for new game “clothes pin tag”

10:36 am-start clothes pin tag game

10:37 am-Asal stop the game because the kids were misbehaving and not following the rules of the game

10:38 am-restart clothes pin tag game

10:44 am-end clothes pin tag game

10:46 am-water break

10:49 am- return from water break/instruction for new game “fire fighter”

10:50 am- started the game

10:54 am-end the game

10:54am –instructions for octopus game

10:56 am-start octopus game

11:02 am-pick new octopus

11:03 am-continue to play octopus

11:08 am –end octopus game

11:08 am– instructions for “name game”

11:09 am-start name game

11:16am-end name game

11:16am –instruction for “crocodile” game

11:19 am –start crocodile game

11:23 am-end crocodile game

11:23 am –instructions for “flip the fish” game

11:29 am– start flip the fish game

11:35 am – finished kin kid program

11:35 am-water break

11:39am- return back to classroom

11:40 am- sat on the carpet and played name game

11:58 am –end name game and then wash their hands

12:03 pm-lunch time

12:24 pm –end lunch time

12:24 pm- start to play with board game/Lego /colouring

12:57 pm –clean up time to put away the board game/Lego/crayons

1:00 pm-finished putting away toys /sat on the carpet

1:04 pm-walk to a different classroom and sat to listened to the camp rules

1:16 pm-finished explain the camp rules and walk to the park

1:32 pm-played at the park (played with soccer ball or hula hoop)

1:58 pm –finished playing at the park and return to class

2:03 pm- wash hands

2:11 pm-everyone finish washing their hands

2:13 pm-snack time

2:25 pm-end snack time/clean up/wait for instruction for next activity

2:34 pm art and craft time

3:02 pm end art and craft time /clean up

3:02 pm –sat on carpet and listened to new instruction for next activity “throwing ball game”

3:16 pm-end game “throwing ball game”

3:16 pm –started to play 5 up (similar game as seven up)

3:30 pm-end 5 up game/took off acc from kids

Thursday July 03, 2014 (full day)

9:20 am- started playing Lego, board game, colouring

9:40 am- clean up time (put away Lego, board game)

9:46 am – started to play name game

9:51 am- end name game and then washed their hands

10:00 am-everyone finished washing their hands

10:00 am– snack time

10:15 am-end snack time and then clean up

10:18 am –walk to the gym

10:20 am-start kin kids, ran around the gym

10:24 am-finished running

10:24 am-started stretching

10:27 am –stop stretching

10:27 am-instructions for Crash game

10:28 am-start Crash game

10:32am –end crash game

10:32 am-instruction for new game `freeze tag`

10:33 am-start freeze tag game

10:38 am-end freeze tag game and then instructions for new game ``blog tag``

10:42 am –start blog tag

10:47 am- stop blog tag

10:47 am-water break

10:51 am-return from water break

10:51 am-instructions for new game ``toilet tag``

10:59 am-stop playing toilet tag

10:59 am-instructions for octopus game

11:01 am- start octopus game

11:09 am –pick a new octopus

11:15am- stop playing octopus game

11:16 am–instruction for new game ``what time is it Mr. Wolf``

11:19 am- started the game’ what time is it Mr. Wolf’

11:33 am –stop playing ‘what time is it Mr. Wolf’

11:33 am –end kin kids and line up to return to class

11:44 am – return to class and played hot potatoes

11:55 am –finish playing hot potatoes and then wash their hands

12:02 pm- lunch time

12:17pm-end lunch time

12:17 pm – start playing board game, Lego, colouring,

1:07 pm- clean up time (put away board game, colouring, Lego)

1:11 pm-end clean up time

1:20 pm-start playing a throwing ball game

1:25 pm- stop the throwing ball game

1:25 pm- walk to the gym

1:30 pm-sat and listened to an anti bully presentation

2:19 pm-end presentation on anti bully

2:20pm-walk to classroom

2:25 pm-wash their hands

2:33 pm-finish washing their hands and snack time

2:45 pm-end snack time

2:45 pm-some kids played soldier ball game, hangman game or hot potatoes

3:20 pm – stop playing soldier ball game, hangman and hot potatoes

3:20 pm-started playing with Lego, board game or colouring

3:30pm- took off acc

Friday July 04, 2014 (full day)

9:00-9:47 Free play indoors. (board games, colouring, building blocks)

9:47-9:55 Tidy up

9:55- 10:00 Seating and washing up

10:00- 10:12 Snack Time

10:16-10:28 Red light, Green Light

10:28-10:29 Sit in circle and explain next game

10:29-10:37 Mr. Wolf

10:37-10:40 Kids in circle and explain next game

10:40-10:46 Octopus- Octopus

10:47-10:49 Selecting new Octopus

10:49-10:52 Octopus- Octopus
10:52-10:54 Kids in circle and explain next game
10:54-10:57 Fishes and Whales
10:58-11:02 Water break
11:02-11:05 Kids in circle and explain next game
11:05-11:13 Freeze tag
11:13-11:15 Kids in circle and explain next game
11:15-11:20 Hot potato in Circle while sitting
11:20-11:25 Random Running
11:25-11:27 Sitting to organize next game/ next part of the day
11:27- 11:45 Various games in gym (basketball, jump rope, hoola hoop, catch)
11:45-11:50 Walk back to class
11:50-11:59 Washing up
11:59-12:30 Lunch
12:30-1:00 Indoor activities
1:00-2:00 Arts and Crafts
2:00-2:25 Snack time
2:25-2:35 Prepare for outdoor activities
2:35-3:30 Outdoor activities/ Jungle gym

July 09, 2014 (3 sites pilot)

Child 1

11:01-jump rope
11:03-stop

11:05-obstacle course (run, kick ball, run after ball, pick it up dribble ball to start line.

play catch)

11:07-stop

Child 2

11:08- start run and kick

11:11-start dribble

11:12-stop

11:13-start catch

11:14-stop

11:15-start hopscotch in playground

11:16-stop

11:18-start throw ball in the air and catch it

11:21- stop

July 10, 2014

GS1

10:05 am- stretches

10:10 am- stop stretches

10:10 am- instruction for new game (crocodile)

10:12 am-start game (crocodile)

10:17 am- end game (crocodile)

10:17 am-instruction for blog tag game

10:19 am- start game (blog tag)

10:23 am- pick a new blog tag it

10:24 am-continued the game (blog tag)

10:31 am- end game and then kid sat on the floor

10:32am- instruction for new game (octopus)

10:34am- start game (octopus)

10:46am- end game and then sat on the middle

10:48 am-instructions for new game (crash)

10:49 am – start game (crash)

10:57 am-end game (crash)

10:58 am- took off belt

GS2

11:06 am –stretching

11:08 am-end stretching and then instructions for new game (four way soccer)

11:11 am- start the four way soccer game

11:18am -end game (four way soccer game) and then kids line up against wall

11:21am- instructions for new game (throwing Frisbee)

11:23 am-start Frisbee game

11:24 am- stop Frisbee game because the kids did not follow the rules of the game

11:25 am- instruction for new game (monkey in the middle)

11:27 am – start the game (monkey in the middle)

11:32am- end game (monkey in the middle)

11:33 am –instruction for new game (hot potatoes)

11:37 am- start game (hot potatoes)

11:45am- end game (hot potatoes)

11:46 am-instructions for new game (Simon says)

11:50 am-start game (Simon says)

11:56 am- end game (Simon says)

11:58 am –took off acc

Friday July 11, 2014

GS1

10:34 am – stretches

10:39 – end stretches / instruction for new game

10:40 – start crocodile game

10:47 – end crocodile game

10:48- new instruction for game (Blog tag)

10:49-start blog tag game

10:56- time out for the kids because they did not listen to the rule of the game

10:57- continue to play the game (blog tag)

10:59 – end game /

11:00- instruction for new game (octopus)

11:01-start game (octopus)

11:09- pick new octopus

11:10 –continue the game octopus

11:15- new instruction for new game crash

11:16- start game crash

11:28 – end game /took off belt

GS2

11:40 –start stretches

11:44- end stretches

11:45-instruction for 4 way soccer

11:48- start 4 way soccer game

11:52-stop game /count number of soccer ball for each team

11:54-continue the game (4 way soccer)

12:04-end game /sat on the middle

12:05 –water break

12:07-return from water break /instruction for new game (hot potatoes)

12:09-start hot potatoes game

12:15-end game

12:16-instruction for new game (Simon says)

12:19- start game

12:30 –end game

July 14th 2014

GS1

10:26-10:33 Stretch and run

10:33-10:47 Simon says

10:48-10:58 Archers tag

11:02-11:14 Clothespin tag

11:20-11:26 Crows and cranes

GS2

11:35-11:41 Stretch and run

11:41-11:52 Simon says

11:56-12:06 Pass it on

12:08-12:15 Clear out

12:18-12:23 Freeze tag

12:25-12:30 octopus

July 15, 2014

GS1

10:37- start stretches

10:41-end stretches

10:41- instruction for new game (hospital tag)

10:50- end hospital game

10:50-start instruction for charades game tag

10:52-start charades tag game

11:01- stop playing

11:01- instruction for blog tag game

11:02-start blog tag game

11:08-stop game then Asal ask the kid who got tag during the game

11:09 –return to blog tag game

11:11-water break

11:13-return from water break

11:15-instruction for new game (cat mouse game)

11:17-start game (cat mouse game)

11:20-stop game / instruction for new game (crash game)

11:21-start crash game

11:26-stop crash game /instruction for octopus

11:28-start octopus game

11:32 stop octopus game / took of belt

GS2

11:42 – kid ran around the gym

11:43-start stretches

11:44-stop stretches /instruction for 4 way soccer

11:47-start 4 way soccer

11:54-stop/count number of ball score

11:55-restart four way soccer

12:02-count the number of ball scored/stop game because kids were misbehaving

12:07- start Simon says

12:11-stop game/new instruction for freeze tag

12:13-start freeze tag game

12:20-stop game/instruction for crash game

12:20-start crash game

12:29 – stop game/took off acc

July 16,2014

GS1

10:37- start running
10:38-stop time/instruction for new game “ see you alligator”
10:40 –start time for see you alligator game
10:50-stop game/instruction for octopus game
10:52-start time for octopus game
10:57-pick a new octopus
10:58-continue to play octopus
11:04-stop octopus game
11:05-instruction for crocodile game
11:06-start crocodile game
11:11-stop crocodile game
11:13-pick new crocodile
11:16-stop crocodile game/instruction for new game
11:18-start blog tag
11:24-stop game/new game (crows and cranes)
11:25-start crows and cranes
11:30-stop game /took off acc

GS2

11:38-start kin kid
11:40-start running around the gym
11:41-stop running
11:42-start stretches
11:45-instruction for 4 way soccer

11:46-start 4 way soccer

11:51-stop game to count number of ball collected for each team

11:52-return to play 4 way soccer

11:57-stop playing and count the number of ball each team collected

12:08-stop playing 4 way soccer/ instruction for Simon says

12:09-start Simon says

12:20-stop game/put away the ball

12:25-instructio for new game (pass it on)

12:27-start game

12:30-stop game /took off belt

July 18, 2014

GS1

10:34-kid got to the gym and line against the wall

10:35-Start running around the gym

10:36-stop running

10:36-start stretches

10:41-stop stretches

10:41-instruction for fitness tag

10:43-start fitness tag

10:55-stop fitness tag

10:56-instruction for blog tag

10:57-start blog tag

11:00-pick a new blog tag

11:01-continue blog tag game

11:09-stop blog tag

11:10-instruction for what time is it Mr Wolf

11:11-start what time is it Mr Wolf

11:21-stop game/instruction for new freeze tag using bean bag

11:24-start game

11:26 change the rule of the game and continue to play freeze tag

11:28-stop game / took off belt

GS2

11:40-start kin kids

11:43-streches/instruction for new game

11:45-start 4 way soccer

11:55-stop 4 way soccer

11:56-instruction for game (using racket and balloon)

12:00 – start game

12:13-stop game /put away the racket

12:15-instruction clear out game

12:19-start clear out game

12:24-stop game

12:24-instruction for new game (throw the balloon through the hula hoops)

12:30-end game /took off belt

Monday July 21, 2014

GS1

10:29-charades tag instruction

10:31 – start charades tag

10:34 – stop and pick a new person to tag others

10:34-continue to play

10:41-stop charades tag/instruction for crocodile game

10:42- start crocodile game

10:48-stop crocodile game/instruction for fishes and whales from kids and the leader

10:51-start fishes and whales

10:58-stop fishes and whales

10:59-instructions for cat and mouse

11:00- start cat and mouse

11:09-stop game /instruction for arch tag

11:12-start arch tag

11:14-pick a new partner for the arch tag

11:15-continue to play arch tag

11:20- stop and sat in the middle

11:21-instruction for crash game/water break

11:24-returned and start to play crash

11:30-stop game

GS2

11:38-start instruction for warm up

11:40-start running

11:41-stop running / divide kid in different team

11:42- start 4 way soccer

11:48-stop 4 way soccer/ count the number of ball for each team

11:49-put the ball back to the middle

11:50 – continue to play 4 way soccer ball

11:56-stop

11:57-instruction for throwing the ball through the hula hoop

11:57-start game

11:58-stop the game for new instruction and then continue to play

12:14-stop playing the game

12:15-instruction for hot potatoes

12:17-start hot potatoes game

12:20-stop game and instruction for clear out game

12:25-stop game

12:26-then the kids were instructed to hold the balloon over their head and to run around the gym

12:27- start Simon says game

12:31-stop game /took of belt

July 22, 2014

GS1

10:34 –warm up lap

10:35-stop

10:36-stretch (start)

10:41-finish stretch

10:43-start see ya later alligator

10:55-Stop game/instruction for fitness tag

10:58-start fitness tag

11:03-pick a new it

11:07- again pick new it

11:09 –game stop

11:11- start what time it is Mr Wolf

11: 22-stop

11:23-instruction for freeze tag using bean bag

11:24-stop the game to re- explain the game

11:25-continue the game

11:30 stop the game

GS2

11:35-kids arrived to the gym

11:36-warm up lap and stop

11:38-stop

11:38-start stretches

11:42 stop stretches/line up against the wall for new game instruction

11:44-start playing with racket and balloon

11:55-stop game

11:58-instruction for clear out game

11:59-start clear out throw game

12:08-stop playing

12:09-start to throw the ball through hula hoops

12:20-stop game

12:21-start Simon says

12:31-stop /took of belt

July 23, 2014

GS1

10:33-kin kids starts

10:34-instruction for kid to line up

10:35-warm up –lap around the gym

10:37-stop

10:37-calesthis (arm rotation/stretching)-balance

10:40-stop

10:40-blob tag start

10:44-re-set and go

10:48-stop

10:51-wounded tag start

11:01-stop

11:03-bacon tag (like freeze tag but lie down and sizzle)

11:12-stop

11:13-start octopus

11:19-stop/reset

11:20-restart octopus

11:23-stop

11:24-red light/ green light

11:30-stop

GS2

11:39-kin kid start

11:40-warm up –lap around the gym

11:42-stop running/sat in the middle

11:43-start stretches

11:46-stop/instruction for freeze tag using a ball

11:48-start game

11:57-stop game/kids waited for the next instruction

12:00-start Simon says

12:07-stop game/put away the ball

12:09-kids choice of game (hot potatoes)

12:10-start hot potatoes

12:11-stop game for new rules for the game

12:12-continue to play

12:20-stop game

12:22-crow and crane instruction

12:23-start game

12:28-stop and then start a new game (kick the ball)

12:30 stop game /took off belt

July 24, 2014

GS1

10:32-start kin kids/warm up (lap around the gym)
10:33-stop/then ran again
10:34-stop running
10:35-start stretches
10:38-stop
10:39-instruction for charades tag
10:38-start
10:48-stop/instruction for crash
10:49-crash start
10:57-stop/instruction for fishes and whales
10:59-start
11:09-pick new shark
11:05-continue to play
11:08-stop game
11:09-instruction for cat and mouse
11:10-start
11:17-stop/instruction for crows and crane(divide the kids in two team)
11:20-start crows and crane
11:22-stop game
11:23-instruction for flip the fish and divide kid into team
11:27-start game
11:30 stop and took of belt

GS2

11:38-kid arrived to the gym
11:40-warm up –lap around the gym
11:41-stop
11:42-stretches start
11:45-simon says using ball instruction
11:47-start Simon says
12:00-stop and sat in the middle
12:01-new game pass it one
12:05-start
12:08-stop game and then instruction for doge ball elimination
12:11- start
12:30 –stop and took of belt

July 25, 2014

GS1

10:34 Stretching/ Warm up
10:40 Fitness Tag
10:55 Clothes Pin tag
11:09 Crocodile Crocodile
11:19 Blob Tag
11:28 Bacon tag

GS2

11:41 Stretch/Warm-up
11:50 Four way soccer
11:59 Balloon Keep ups
12:17 Throw balls in a hula-hoop

July 28, 2014

GS1

10:32-warm up-lap around the gym
10:33-stop because kids were not listening
10:34-continue to run
10:35-stop
10:36-start stretches
10:40-stop
10:40-start Simon says
10:46-stop game
10:46-instruction for arch tag
10:47-arch tag start
10:53-stop game
10:54-instruction for clothespin tag/distributed the clothespin to the kids
10:57-start clothespin tag
11:13-stop/collect clothespin tag
11:14-instructions for crowns and crane
11:16-start game

11:22-stop game/instruction for DR. Doge ball

11:25-start game

11:31-stop/take off belt

July 29, 2014

GS1

10:30- start stretches

10:36 stop stretches

10:37-instruction for hospital tag

10:38-start hospital tag

10:47-stop hospital tag

10:48-Kin kid leader showed kids how to run properly

10:49-instructions for charades

10:50-start charades

11:00- stop game/instruction for blog tag

11:01-start blog tag

11:07-stop blog tag/(Asal ask kids who they caught and pick new it for blog tag)

11:08-restart game

11:11-stop game

11:12-start game (cat/mouse)

11:17-stop

11:18-asal show motor skill to the kids (Gallop)

11:19-Stop/demonstration for next skills (shuffle to the side)

11:20- start sliding to the side (shuffle)

11:21-stop

11:21-jump across the gym

11:22-stop/again demonstrate the kids how to jump

11:23-start jump

11:24 –stop

11:24- instruction for hooping 3 times on one leg

11:24-start hooping

11:26-stop

11:26-demonstrated leaping

11:27-start leaping

11:29-stop

11:29-start crash/game

11:31-stop game

GS2

11:37-warm up (lap around the gym)

11:38-stop

11:39-start stretches

11:41-stop/instruction for crows and crane (but they used ball to throw in the other side similar game to dodge ball)

11:42-start /but stop game immediately because kid weren't following the rule of the

11:45-restart the game

11:50-stop /instruction for doctor doge ball

11:55-start doctor doge ball

12:03-stop

12:04-ballon and racket game (similar to tennis)

12:14-new rule for the game to hit the balloon like a baseball bat

12:32-stop the game

July 30, 2014

GS1 (10:30-11:30)

10:29-warm up (lap around the gym)

10:31-stop

10:31- start stretches

10:36-start see you alligator

10:48-stop see you alligator/instruction for octopus

10:49-start octopus

11:01-stop octopus/instruction for crocodile

11:03-start crocodile

11:12-stop crocodile/instruction for blog tag

11:14-start blog tag

11:22-stop blog tag/instruction for bacon tag

11:24-start bacon tag

11:30 – stop bacon tag/took off belt

GS2

11:38-warm up (lap around the gym)

11:39-stop running

11:39-start stretches

11:41-stop stretches/instruction for doge ball

11:44-start doge ball

12:07-stop Doge ball/instruction for clear out

12:09-start clear out

12:30-stop clear out

July 31, 2014

GS1

10:35-10:39 Warm-up by running laps around gym

10:39-10:43 Stretch

10:43-10:57 Fishes and Whales

10:57-10:58 Sitting in Circle

10:58-11:06 Blob Tag

11:06-11:07 Sitting in Circle

11:07-11:14 Cat and Mouse

11:14-11:16 Sitting in Circle

11:16- 11:37 Doctor Dodgeball

GS2

11:41- 11:43

Kids enter + warm up by running laps around gym

11:43-11:48

Stretching

11:48-11:50

Sitting in Circle

11:50-11:59

European Hand Ball

11:59-12:02

Sitting in Circle

12:02-12:22

Freeze tag with balls

12:22-12:24

Sitting in Circle

12:24-12:31

Doctor Dodgeball

12:31

Line up and Leave

August 1, 2014 (full day)

9:15-all kid in one classroom colouring, playing with Lego or playing with toys such as cars, dolls

9:53-stop/clean up

9:58-stop cleaning/sat on the carpet and listen to camp rules

10:04-split the kid into two groups

GS1:

10:04-clean up their hands

10:07-snack time

10:16-end snack time /clean up

10:21-start freeze dance

10:24-stop freeze dance game/walk to the gym

10:31-kin kids start (warm up lap around the gym)

10:32-stop running/start stretches

10:36-stop stretches

10:36-start fitness tag instruction

10:37-start fitness tag

10:42-pick a new it

10:47-stop fitness tag

10:48-instruction for blog tag

10:49-start blog tag

10:56-pick a new it/restart the game

11:00-stop the game and instruction for what time is it Mr wolf

11:01-start what time is it Mr wolf

11:06-pick new wolf/restart the game

11:10-stop the game/instruction for clothespin tag

11:12-start clothespin tag

11:19-stop game/instruction for doge ball

11:23-start dogeball

11:27-stop game

11:28-restart the game

11:32-end kin kids

11:35-went to the park

12:00-lunch time

12:30-end lunch time

12:30-started to play with lego ,colouring, played with toys

12:59-clean up

1:03-started to play with the hula hoop (in a group tried to put the hula hoop through their body)

1:06-stop playing

1:14-Art/craft

2:05-clean up

2:10-snack time

2:20-end snack time

2:29- watch movie

3:30-start to take off belt

GS2

10:20- went to the park

11:35-arrived to the gym for kin kids

11:37-warm up (lap around the gym)

11:38-stop running /start stretches

11:41-stop stretches/ divided the kid into group for dogeball

11:43-start dogeball

11:50-stop

11:52-restart dogeball

11:56-stop game /disturbuted the racket and ballon/instruction for racket ballon

11:58-start racket ballon game (similar to tennis)

12:18-stop the game/put away the equipment

12:20-threw the ballon though the hula hoops

12:30-stop playing

12:31-walk to their classroom

12:33-wash their hands/washroom

12:40-lunch time

1:01-end lunch/start colouring and reading book

1:12-clean up time

1:14-art and craft making mask

2:05-stop clean up

2:09-snack time

2:21-end snack time /clean up

2:25- walk to the other classroom to watch movie

2:29-watch movie

3:30-start to take off belt

August 5, 2014 (3 body site)

GS1

10:32-start running

10:33-stop running

10:33-start stretch

10:36-stop stretch

10:37-start dogeball

11:00-end dogeball

11:02-octopus

11:15-stop octopus

11:15-start blob tag

11:23-stop blob tag

11:24-start clothespin tag

11:34-stop clothespin tag

GS2

11:40-warm up (lap around the gym)

11:41-stop/instruction for dogeball and set up

11:44-start dogeball

11:47-stop the game kid didn't listen to the rules

11:48-restart doge ball game

12:02-stop the game /distribution of racket and balloon and instruction

12:04-start balloon with racket

12:17-stop/instruction for clear out

12:18-start clear out

12:34- new game (ballon throw the hula hoops)

12:37-stop the game

12:37-took of belt

August 6, 2014 (full day)

9:12-start playing with lego, board game and toys such as cars and dolls

9:52-clean up

9:55-sat on the carpet for camp rules

10:00- divide the kid into their group

GS1

10:01- start washing their hands

10:05-snack time

10:16-end snack time/put away lunch bag

10:18-sat on the carpet to read book

10:20-played soldier ball

10:32-arrived to kin kids (warm up -lap around the gym)

10:33-stop running/start stretches

10:35-stop stretches

10:36-start see you alligator

10:46-stop the game /instruction for octopus

10:47-start octopus

10:52-pick new octopus/restart octopus

10:56-pick new octopus

10:57-restart octopus

10:59-stop the game/instruction for clothespin tag

11:02-start clothespin tag

11:10-stop the game/collect clothespin tag

11:11-instruction for doctor dogeball/divide the kid into team

11:13-start dr.dogeball
11:22-stop dr.dogeball
11:24-start crows and crane
11:30-end game crow and crane
11:30-walk to the park
12:00-lunch time
12:30-colouring, Lego, played with toys
12:56-clean up time
1:03-line and walk to the gym
1:06-(zumba) the instructor of zumba introduced herself to the kids
1:11-streches (zumba)
1:12-start zumba
1:38-end zumba
1:40 took of belt kids going swimming
2:40-snack time (put the belt on this kids at 2:33pm)
2:48-end snack time
3:00-clean up time
3:11-sat on the carpet
3:23-at the gym (played soccer (**acc 6 and 27**), played tag (**acc30**))
3:30-took of the belt

GS2

10:01-wash hands
10:05-snack time

10:24-end snack time

10:27-played seven up

10:50-walk to the park

11:35 arrived to the gym for kin kids

11:36-warm up (lap around the gym)

11:37-stop running

11:38-start stretches

11:40-stop stretches

11:41-instruction for dogeball/divide the kids into group

11:44-start dogeball

11:54-stop

11:55-start clear out

12:07-stop clear out

12:09-instruction for simon says

12:10-start simon says

12:19-stop game/instruction for 4 way soccer

12:20-start 4 way soccer

12:30-stop game

12:40-lunch time

12:57-end lunch time

12:57-read a book

1:00-time out for the kid for being loud (maintain sedentary)

1:23-art and craft

1:40-zumba

2:18-end zumba

2:21-art and craft

2:32- took of belt for swimming

August 15,2014

GS1

10:49- kin kid starts

10:51- octopus start

10:56- stop/pick new octopus

10:56-restart

10:58-stop/instruction for doctor dodge ball /divide the kids

11:02 start dogeball

11:11-stop

11:13-blob tag start

11:24- stop game/instruction for fast food

11:29-start fast food

11:35-stop

11:38-start wax museum

12:08-stop playing

APPENDIX C: St. Augustine Activity Observations

Monday June 30, 2014 (full day)

STARTED LATE BECAUSE OF MOVE TO GOSFORD – NEEDED TO WAIT FOR JULY PERMIT

10:30- Snacks

10:35- Finish snacks/instruction for square

10:36- Square

10:45:20- finish square/instruction for evolution

10:48:37- Evolution

10:50:44- Finish evolution/going outside

10:55:25- Playground/free play

10:59:55- Instruction for spud

11:03:58- Spud

11:12:33- Finish spud/instruction for chain tag

11:14:56- chain tag

11:21:06- Finish chain tag/soccer baseball instruction

11:27:55- Soccer baseball

11:46:48- Finish soccer baseball/ move inside

11:55:13- Lunch

12:23:32- Playing cards/hangman

12:45:12- Pictionary

13:06:08- finish Pictionary/move to gym

13:12:34- Dodge ball

13:20:54- doctor dodge ball

13:47:50- Finish dodge ball/water break
13:55:38- cat and mouse
14:02:46- Break
14:05:30- Snack
14:21:56- Finish snacking/ going outside
14:23:46- playground/ free play
14:48:13- move to the gym
14:53:22- Adams
15:01:02- Octopus
15:03:51- Finish octopus/ move to classroom
15:07:58- 7-Up
15:15:52- End 7-up/ instruction for detective
15:18:55- Detective
15:26:51- Finish detective/going back to St. Augustine

Wednesday July 2, 2014 (full day)

9:15 – 9:30 -> Camp instructions
9:30 – 9:37 -> Icebreakers; saying each other's name while passing ball around circle
9:37 - 9:52 -> Huckle Buckle
9:52 - 10:02 -> Ship to shore
10:02 – 10:22 -> Snack time
10:22 – 10:32 – Changing into swim outfits **took off ACC
-SWIM at DRIFTWOOD –

12:35 – 1:10 -> Lunch

1:10 – 2:01 -> Gym time; bench ball

2:01 – 2:40 -> Snack time

2:40 – 3:06 -> Split into groups:

-7 & 8 year olds played bump inside gym

-8 & 12 year olds played games sitting down in a classroom

-6 year olds did arts & crafts

3:06- 3:15 -> ladder race in the gym

3:15 – 3:25 -> Silent ball; sitting down passing ball without making noise

3:25- 3:30 -> throwing ball around in circle

Thursday July 3, 2014 (full day)

9:31 – 9:51 -> Go outside to play soccer baseball

9:57 – 10:16 -> Snack time

10:16 – 11:03 ->Board games

11:03- 12:03 -> Group splits.

- 8 to 12 year olds in did arts & crafts
- 6 year olds did activities in classroom
- 8-9 went into the gym to play games

12:04 – 12:47 -> Lunch Time

12:47 -1:13 -> Board Games

1:20 – 2:10 -> Movie inside the gym : Watched Frozen

2:10 – 2:13 -> went to get snacks

2:14 – 3:30 -> Continue watching Frozen

Friday July 4, 2014 (full day)

9:08- 9:10 -> Instructions

9:10 – 9:15 –>British Bulldog – similar to tag

9:23 – 9:33 -> Knights, cavaliers, and horses

9:36 – 9:56 -> dodgeball like game called SPUN

10:01 – 10:24 -> Snack

10:24- 10:46 -> Board Games

****After board games I removed ACC for the water work event*****

12:01 – 12:45 -> Lunch Time

12:45 – 1:21 -> Board Games

1:22 – 1:38 -> Octopus

1:38 – 1:44 -> Team tag

1:45 – 1:49 -> line octopus

1:50 – 1:56 -> Curly Larry Moe

1:56 – 2:03 -> Instructions for upcoming event

2:03 – 2:25 -> Snack time

2:30 – 3:30 -> Split into different stations; rotate every 15-20minutes

- Food tasting station
- Blind Fold Game
- Dancing
- Outdoor racing/obstacles

July 07 2014

1:20 pm –kids divided into different room and activities (craft room, Gym, classroom (played games such as soldier man, throwing the ball))

1:45pm-those that were playing in the gym walk back to the craft room

1:36pm – those that were in the craft room walk to the gym and played games (ship/shore and atoms) and stop playing at 1:50pm

1:58 pm-those that stayed in the classroom played soldier man and stop playing at 2:00 pm

2:00 pm-snack time for those that were in the gym and in the classroom and ended their snack time at 2:18 pm. After snack time played board games.

2:18pm- the kids in the craft room started their snack time

2:34 pm–ended their snack time and then joined the other group for board games

2:45 pm – end board game and clean up time

2:53 pm – kid split into different room craft room, gym and classroom

3:00 pm- took off acc

July 08, 2014

1:00 pm-board games

1:40 pm –end board games/clean up time

1:54pm-walk to the gym

1:58pm–instruction for dodgeball

2:02 pm-start dodgeball game

2:16 pm- end dodgeball game for some of the kids because they walk back to the craft room

2:18 pm- those kids that stayed in the gym continued to play dodgeball

2:29pm-stop playing dodgeball and then walk back to class for snack time

2:33 pm – snack time for those that walk back from the gym and end snack time at 2:40 pm

2:53 pm- walk to the gym

2:58pm- started to take off the acc

Monday July 14, 2014

1:15 – 1:36 Dodge ball

1:40 – 1:47 Elephant ball

1:48 – 1:54 Ships to shore

1:54 – 1:58 Octopus

1:59 – 2:15 Snack

2:15 – 2:20 Guessing games (sitting)

ACC #19, 21,31,5,34

2:20 – 3:00 Free time (playing cards)

ACC #1,4,13,12,14,23,8

2:20 – 3:00 Drumming

July 15,2014

1:00-finish lunch /cleaning up

1:26- split into groups (classroom, art/craft, Gym)
1:26-classroom (played board game), snack time at 2:04
1:26-art/craft (kids made key chain), snack time at 2:11
1:27- group in the gym played octopus /1:40-end octopus game and then start to play
rocket game and end at 1:46 ,at 1:47-played soccer ball using their hands, stop playing at
2:12 ,snack time at 2:14
2:27 –end snack time
2:27-those that finished snack started drawing at the chalk board
2:32-all kids were told to sit down
2:40-played picnic game sitting down
2:46- hangs man game start
2:55-walk to the gym and there split the group again
2:59 – took off belt

July 16, 2014

1:00 -> Start time ; 7-up Game
1:11 -> Stop game
1:11 – 1:15 -> Instructions/attendance
1:15 -> Go to gym/park
1:21 -> Inside gym
1:24 -> Some kids play in the gym while others go play at the park
1:35 -> Park group comes back due to rain
1:40 -> Game start: Huckle Buckle

1:50 -> Game stop.

1:52 -> Start Game; Ship to shore

1:56 -> Game stop ; snack time

2:18 -> Board games

2:49 -> Silent Time; heads down

2:53 -> Go gym and sit

3:00 -> Take off belts

July 18, 2014

1:10 -> sitting down at DCC for instructions

1:13 -> Dancing to music ; Light party

2:27 -> Dance party over

2:30 -> Snack time

3:00 -> Take off belts

July 22, 2014

1:00-played board game

1:36-start clean up and putting away games/then sat on the chair

1:46-line up to go to the gym

1:48-start to walk to the gym

1:51-instruction for octopus

1:55-start octopus

1:59-stop/then played freeze dance (those that move will sit out)

2:11-stop game/kids waited for next game instruction

2:13-instruction for Adam game

2:28-stop and line up to go back to classroom

2:33-snack time

2:46-end snack time

2:49 sat on the chair played classroom game (what Mickey like ?)

2:58-start taking off acc

July 23,2104

1:00 – Start: Board games

1:28 – Stop

1:31 – Go gym for instructions

1:37 – walk to park

1:54 – Play at park

2:30 – walk back to school

2:41 – Game: pac man

2:50 – Stop

2:51 – Game: British bulldogs

2:55 – Stop

3:00 – take off

July 24, 2014

1:00 – Game: Basketball bump

1:20 – Stop

1:22 – 1 on 1 wrestling ; trying to take each other socks off

1:35 – Stop

1:35 – Half see movie, other half go park

1:47 – Walk to park

1:56 – Play at park

2:57 – Walk back

3:00 – Take off

July 28 2014

12:59 – 13:14 Bump

13:23 – 13:29 Bench-Ball

13:52 – 14:00 Octopus

14:02 – 15:00 Snacks/playing cards

July 31, 2014

1:00 – board games

1:17- Stop Board games

1:19 – Split into groups of 3 : art, classroom games, & Frisbee

2:02 – Snack time

2:15 – Board Games

2:38 – Stop board games

2:41 – Group split into respective team and practice their dance for talent show

3:00 – Take off belt

Aug. 1, 2014

9:00 – Playing a game of bump

9:15 – Free play

9:34 – Stop games: take attendance

9:43 – Game: Snake’s Tail

9:48 – Stop game

9:54 – European handball

10:04 – Stop game

10:08 – Snack time

11:01 – Go to gym

11:10 – Split into groups for theme day

Station 1: Parfait making

Station 2: Art

Station 3: Build tallest tower with cards

Station 4: Croquet

12:35 – Lunch time

1:10 – Board Games

1:33 Stop Board games

1:37 – Take of belts for #12, 19, & 4 for water play

2:00 – Put back on because we had to go back inside for cake

2:05- Sang happy birthday to Allen and ate cake

2:24 – took off all belts for water play this time

3:30 – Leave.

August 5,2014 (3 body site)

12:50-start to put the belt on the kids/kids played board game at the time

1:12-clean up time

1:20-divide the kid into group

1:22-walk to the gym

1:25-arrived to the gym and sat for a Pan Am presentation (guest speaker)

1:38-start to dance a choreography that the guest speaker made for the Pan am
game

1:41-end dancing

1:42-sat on floor and divide the kid into team for a Pan AM games

1:54-instruction for volleyball (played volleyball while they sat on the floor)

1:56-start the game

2:01-stop game and line to go to class

2:02-walk back to classroom

2:04-snack time

2:24-end snack time/maintain sedentary

2:41-line up kids and walk to the gym

2:45-arrived to the gym

2:48-divided the kids back into their Pan Am game (played games like hockey on a scooter, kid blind folded while they did an obstacle course and their teammate will guided them)

3:01-took of belt

August 6, 2014

9:00 – Free play inside gym

9:30 – Stop/ take attendance

9:40 – Game: Huckle Buckle

9:50 – Snack break

10:08 – Break over

10:10 – Take off belts for those who swam

10:41 – Walk to DCC

11:00 – The rest played cards while other kids swam

12:00 – Walk back to SAS

12:20 – Lunch time

12:43 – Board games

1:40 – attendance

1:46 – split into groups to practice dance routine

2:30 – Snack time / board games

2:52 – Silent time

3:02 – classroom game

3:12 – Gym activities ; dodgeball & dancing

3:30 – Take off