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THE IMPACT OF THE SEMOSTI PROGRAMME ON THE GROSS MOTOR PROFICIENCY OF FOUR-TO-SIX-YEAR-OLD CHILDREN

By

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DECLARATION

Student number: 27423795

I, Emily Salzwedel, hereby declare that "*The impact of the SEMOSTI programme on the gross motor proficiency of four-to-six-year-old children*" is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Signed: ____________________________

Date: ______________________________

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First of all to my dear husband, Jason: Thank you for your support, guidance and encouragement throughout this process. I loved sharing this journey with you.

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KEYWORDS

SEMOSTI Programme, gross motor proficiency, four-to-six-year-old children, intervention research, physical activity, BMI, perinatal morbidity, grade R, BOT-2

ABSTRACT

This study investigated the impact of a sensory-motor stimulation programme, namely the SEMOSTI Programme, on the gross motor proficiency of four-to-six-year-old children.

A field experiment was conducted using a quasi-experimental comparison group pretest-posttest design as three teachers implemented the SEMOSTI Programme over a 30-week period. Data collection took place at two schools' grade R classes in Gauteng province of South Africa. Due to a limited sample of 73 participants, the results are context-bound and specific to Afrikaans-speaking, white, grade R children and selected gross motor skills.

Data was collected using subtests of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), a scale and measuring tape as well as several questionnaires. The variables, physical activity, body mass index (BMI), gender, age, and perinatal morbidity could possibly influence the results and were taken into account. Data was statistically analysed using the General Linear Model (GLM) procedure and Dunnett's t-test analysis.

Findings indicated that the SEMOSTI Programme had a significant impact on the dependent variable, gross motor proficiency. The SEMOSTI Programme positively impacted on all five motor skills tested (bilateral coordination, balance, running speed and agility, upper-limb coordination and strength), but

only the impact on running speed and agility and strength were statistically significant.

Findings from the questionnaires indicated that the teachers who presented the SEMOSTI Programme perceived it as user-friendly, well-structured and effective in choice of equipment and activities. They identified the timeframe for the evaluation of developmental milestones and the structure of the plan-of-action section as weaknesses.

Findings suggest that the SEMOSTI Programme is promising in improving gross motor proficiency in four-to-six-year-old children. Through participation in the programme, the experimental group significantly improved total gross motor proficiency, running speed and agility, and strength. This study offers support for the future use of the SEMOSTI Programme as a stimulation programme in grade R after further development and validation.

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LIST OF ABBREVIATIONS

ADHD	Attention Deficit Hyperactivity Disorder
ADHD-C	Attention Deficit Hyperactivity Disorder, Combined
ADHD-HI	Attention Deficit Hyperactivity Disorder, Hyperactive-Impulsive
ADHD-PI	Attention Deficit Hyperactivity Disorder, Predominantly Inattention
ASI	Ayers Sensory Integration ®
BMI	Body Mass Index
BOT-2	Bruininks-Oseretsky Test of Motor Proficiency, Second Edition
BOTMP	Bruininks-Oseretsky Test of Motor Proficiency
DCD	Developmental Coordination Disorder
DST	Dynamic Systems Theory
ECD	Early Childhood Development
GLM	General Linear Model
HPI	Healthy Preterm Infants
HTI	Healthy Term Infants
MABC	Movement Assessment Battery for Children
NGST	Neuronal Group Selection Theory
NMT	Neuro-Maturation Theories
PDMS	Peabody Developmental Motor Scales
PIM	Preterm Infants with Medical Illnesses/Sickness
SIT	Sensory Integration Therapy
GMD	Test of Gross Motor Development
TIM	Term Infants with Medical Illnesses/Sickness
USA	United States of America
WHO	World Health Organisation

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CHAPTER 1 RESEARCH ORIENTATION

1.1 INTRODUCTION

Children make significant progress in their motor proficiency during the preschool period (four-to-six-years) (1), which is attributed to the combined result of the maturation of the brain and body systems and improved skills due to practice (2). Landers (2) claims that differences in the development and functioning of large and fine muscle skills in preschoolers, can be contributed to experience and opportunities to practice. In some children, however, there is a delay in this progress often due to a decline in physical activity and a rise in pathology, which negatively impacts motor proficiency. Motor difficulties can have a serious impact on the child's daily activities, school performance, learning ability and emotional health (3-5). Due to the extent of this possible impact, early screening and intervention for difficulties during the preschool period is strongly recommended (6, 7).

It is the role of the occupational therapist to ensure that the child functions optimally and to enhance the performance of play, attending school and executing daily activities. Occupational therapy has been defined as "the therapeutic use of self-care, work, and play activities to increase independent function, enhance development, and prevent disabilities, [and] may include adaptation of task or environment to achieve maximum independence and to enhance quality of life" (8). Occupational therapy is about improving a person's occupational performance, and within a paediatric setting, children's occupations are usually players, preschoolers, or students (9). Thus, the identification and development of a strategy to enhance motor proficiency in children is an integral part of occupational therapy services (10). The purpose of this research project was to explore the effectiveness of one such strategy, the SEMOSTI Programme, through implementation and analysis of the programme in a school setting.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Approximately 40% of South African children are getting insufficient moderate to vigorous activity each week (11), resulting in fewer opportunities and less experience to practice the large muscle skills and leading to gross motor delays (12). This trend was noticed by the staff and principal of a public primary school in the West Rand prompting them to consult an occupational therapist in December 2005. They had noticed an increase in the number of pupils in the foundation phase that presented with motor difficulties, and therefore requested a stimulation programme for grade R that could be implemented in a school setting. The programme also had to be a tool for early identification of developmental delays which would enable the teachers to give children with difficulties the necessary support before they moved on to grade one. The specific requirements the school had for the programme are discussed in more detail in section 2.5.

After receiving the school's programme criteria, the next step was to review whether such a programme already existed. At this time, the researcher had access to four programme resources (13-16) (summarised in Annexure A). Each programme partially met the above requirements but none satisfied all the requirements and were all outdated.

Programme 1, The Accelerate Programmes, Book Two: Movement Skills Programme (13), developed in 1987, consisted of developmentally-appropriate motor activities structured in a weekly format with a milestone checklist (13). The activities consisted of gross and fine motor activities, yet the programme only covered a period of six weeks and the necessary materials are out of print.

Programme 2, Daily Sensorimotor Training Activities (15), was designed and implemented in the United States of America (USA). The programme consisted of developmentally-appropriate motor activities structured in a weekly format which covered a period of 34 weeks (15). While the programme consisted of gross and fine motor activities, it was developed in 1968 and some activities and equipment were outdated.

Programme 3, Sensory Motor Handbook: A Guide for Implementing and Modifying Activities in the Classroom (14) was developed by three registered occupational therapists in the USA. The programme consisted of 95 motor activities which covered the use of a wide range of equipment (14). The activities, however, were not structured in a daily lesson plan format and were instead categorised according to the equipment used, such as Bean Bags and Bleach Bottle Scoop. Some of the activities were not developmentally-appropriate for four-to-six-year olds, for example the more complex jump rope games.

Programme 4, Bridging with a Smile (16), was written by two South African educationalists and had developmentally-appropriate motor activity ideas. It consisted of a daily stimulation programme with 30 minutes allocated to gross motor activities. However specific activities were not listed or described. The activities were not structured in a user-friendly daily format.

The outcome of this initial programme review led to the decision to design and develop a new sensory-motor stimulation programme for the purpose of the current study. An occupational therapist and the researcher developed a programme, the Grade R Programme, during 2006, over the course of the school year. The programme was implemented on a weekly basis as it was being developed. During the first ten weeks of the Grade R programme, the researcher had weekly meetings with the three teachers at the public school to ensure smooth implementation; thereafter, a quarterly feedback was arranged. By structuring the implementation this way, it was possible to make changes to the programme as it went along, based on how it was received by the school.

The Grade R Programme consisted of daily gross motor activities scheduled for five days of the school week. Each day consisted of a warm-up activity, two stimulation activities and a cool-down activity. The novel activities from week 1 to 10 were repeated over week 11 to 20. Based on feedback received from teachers, this changed to a cycle of repeating a few stimulation activities every fourth week.

The Grade R Programme also consisted of four gross motor developmental milestone forms. The developmental milestones for four-years-six-months, five-years, five-years-six-months, and six-years are given, in terms of balance, movement and ball skills. Teachers were encouraged to assess the children's milestones prior to starting week 1, and during week 21 and week 34.

At the end of 2006, the grade R teachers completed a Grade R Programme questionnaire (Annexure B) to provide formal feedback regarding the user-friendliness and structure of the programme. Their feedback indicated that the following aspects were found lacking in the programme:

- Warming and cooling activities tended to be too repetitive, which bored the children.
- Equipment was not optimally utilised in the programme.
- Some of the activities were not graded properly.
- Some of the choices of activities for presentation in big groups were poor.
- The teachers preferred the cycle of repetition of every fourth week versus the ten-week repetitions.

These findings led to a revision of the Grade R Programme accordingly. The second draft was titled SEMOSTI Programme, which stands for <u>se</u>nsory-<u>mo</u>tor <u>sti</u>mulation. The SEMOSTI Programme focused on the development and maintenance of sensory-motor skills. The theoretical framework and principles that guided the development of the SEMOSTI Programme will be discussed in more depth in section 2.5.

Questions remained, however, whether the SEMOSTI Programme was effective in stimulating gross motor skills in four-to-six-year-old children; whether the teachers were able to implement the activities in the time allocated; and whether the manual was user-friendly. Thus, the purpose of this study was to determine if the SEMOSTI Programme was an effective intervention strategy for stimulating gross motor skills. If the SEMOSTI Programme was found beneficial, further development could be considered after which the SEMOSTI Programme could be offered to other schools as an useful tool for grade R.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTION

The principal's motivation for seeking professional assistance was his desire for the school to play an active role in improving the children's motor skills from an early age, as well as preventing later difficulties in primary school when the child is expected to focus on more academic learning, such as reading and writing. The SEMOSTI Programme was designed and implemented to meet these requirements, specifically to improve gross motor proficiency of four-to-six-year-old children. However, the extent of the impact the programme would have on motor proficiency and individual motor skills was unknown. If the children's gross motor skills improved, it would be unclear whether the progress was due to participation in the SEMOSTI Programme or to natural physical maturation of the brain and body systems. Furthermore, such a stimulation programme had not been researched or published within South Africa at the time of undertaking this research project.

Thus, the following research question was posited to guide this study: What impact did the SEMOSTI Programme have on the gross motor proficiency of these four-to-six-year-old children?

The following factors, effecting the development of motor proficiency, should be taken into account when considering the research question. These factors may impact the effectiveness of the programme. A review of the theoretical knowledge base of child development research identified the following factors that were associated with the development of motor proficiency in children, namely:

- Gender: Boys and girls develop physically in different ways (2).
- Perinatal morbidity: The gestation period and birth weight of infants impact motor development (17).
- Overweight/obesity: Overweight/obesity is associated with poorer development of gross motor skills (18).
- Physical activity: There is a positive association between motor proficiency and physical activity and physical activity is inversely associated with sedentary activity in children (12).

1.4 RESEARCH AIM AND OBJECTIVES

1.4.1 Research Aim

The aim of the research was to establish the impact of the newly developed SEMOSTI Programme on the gross motor proficiency of the four-to-six-year-old children.

1.4.2 Research Objectives Pertaining To Gross Motor Proficiency

To determine the impact of the SEMOSTI Programme on bilateral coordination in four-to-six-year-old children.

To determine the impact of the SEMOSTI Programme on balance ability in four-to-six-year-old children.

To determine the impact of the SEMOSTI Programme on running speed and agility in four-to-six-year-old children.

To determine the impact of the SEMOSTI Programme on upper-limb coordination in four-to-six-year-old children.

To determine the impact of the SEMOSTI Programme on strength, which includes arm and shoulder strength, abdominal strength and leg strength, in four-to-six-year-old children.

1.4.3 Research Objective Pertaining To the Strengths and Weaknesses of the SEMOSTI Programme

To identify the strengths and weaknesses of the SEMOSTI Programme as perceived by three teachers who implemented the programme over the 30-week period.

1.5 DEFINITION AND CLARIFICATION OF CONCEPTS

The following definitions and concepts were applied by the researcher and integral the study:

Agility:

Agility refers to the child's suppleness and quickness during movement (17). It is the ability to move and change position and direction of the body swiftly and effectively while under control and requires well-integrated body coordination (18). Agility is an advanced skill that is built on flexibility and strength, followed by coordination and balance (19).

Alerting Activity:

The term alert refers to a state of being vigilant, attentive and watchful (17). An alerting activity, in the sensory integration frame of reference, refers to a sensory experience which increases the level of alertness. In other words, when a child is feeling sluggish, spacey or day-dreamy, the sensory experience is activating in nature (20).

Arousal:

Arousal refers to a continuum of alertness from low arousal associated with mental lethargy and drowsiness, to high arousal associated with hyperactivity and distractibility (21). Subsequently, the ability to attain and maintain an optimal state of arousal is critical for optimal engagement, attention and learning (20, 21).

Asthma:

Asthma usually begins in childhood but occurs across all age groups. It is characterised by recurrent bouts of breathlessness and wheezing, which vary in severity and frequency from person to person (22). Inflammation leads to the swelling of the air passages, which causes the narrowing of airways, and consequently leads to difficulty breathing (22). Akinbami (23) suggests that symptoms may be triggered by a variety of factors, such as exercise, infections, allergens (e.g., pollen, dust mites, animal dander, etc.), changes in the weather, and exposure to airway irritants (e.g., tobacco smoke). The inflammation may be partially or completely reversed with or without medicines (22).

Attention Deficit Hyperactivity Disorder

Attention Deficit Hyperactivity Disorder (ADHD) is a common, impairing neuropsychiatric disorder (24). ADHD is characterised by age-inappropriate hyperactivity, impulsiveness and deficient sustained attention (24). Although originally conceptualised as a disorder of childhood, it is now known that the disease persists in one-half to two-thirds of children's cases into adulthood (25).

There are three types of ADHD that differ by the following symptoms (24):

- Symptoms of ADHD, Predominantly Inattentive Type (ADHD-PI) (24) include inattention, such as distractibility, poor listening skills, forgetfulness etc.
- Symptoms of ADHD, Hyperactive-Impulsive Type (ADHD-HI) (24) include hyperactivity and/or impulsivity, such as restlessness, impatience, fidgeting etc.
- Symptoms of ADHD, Combined Type (ADHD-C) (24), include all major symptoms of ADHD, including symptoms of inattention, hyperactivity, and impulsivity.

Recent research suggests that the major causative factor of this disorder is genetic (26) and most likely associated with alterations in catecholaminergic regulation of brain activity (27, 28).

Balance:

Balance refers to the body's ability to maintain equilibrium by controlling the body's centre of gravity over its base of support (29). The term balance is used in this study as both static balance (requiring the child to maintain balance while stationary), and performance balance (requiring the child to maintain balance while moving) (30). Balance and equilibrium are components of postural control that are impacted by the vestibular, proprioceptive and visual systems (31).

Bilateral Coordination:

This term refers to sequential and simultaneous coordination of the two halves of the body as well as the upper-limbs with the lower limbs (30). Bilateral coordination and sequencing of actions is built on the immediate perception of the body’s position or movement in space and the ability to use the two sides of the body together (31). Related to bilateral coordination is postural control and bilateral integration and sequencing (31).

Bilateral Integration:

Bilateral integration refers to the brain functions that enable coordination of functions of the two sides of the body (10). This also includes the ability to cross the midline (10).

Body Mass Index:

Body mass index (BMI) is defined as the individual's body weight divided by the square of person’s height (32). BMI is used to indicate a person's ideal body weight in relation to the person’s height (32). A BMI value of 20 to 25 indicates typical weight (33). A BMI value below 20 indicates underweight and above 25 indicates overweight (34, 35).

Children’s’ BMI is calculated by using the same formula as for adults (33), but is not compared to the set thresholds for typical weight, underweight and overweight. As the amount of body fat changes with age, and the amount of body fat differs between boys and girls (36), BMI values for children and teens is often referred to as BMI-for-age. These values are compared to typical values for other children of the same age and gender (37). World Health Organisation (WHO) Child Growth Standards are used to classify children from birth to 5 years (z-scores) and 2007 WHO References are used to classify children from 5 to 19 years (z-scores) (35)

It is important to note that BMI does have shortcomings (36). BMI only takes weight and height into consideration (38) leaving out the percentage body fat and lean body mass (37). Therefore, BMI might overestimate body fat in persons who have a muscular build such as athletes (37). Alternatively, BMI might underestimate body fat in persons who have lost muscle such as elderly people (37).

Calm and Organised Behaviour:

This behaviour refers to the outcome of adequate sensory modulation (31). In a calm and organised or “just right” state, a child can maintain an optimal level of arousal, attention and activity to meet the demands and expectations of the environment and task (31).

Confounding Variables:

Confounding refers to causing surprise or confusion, especially by not acting according with the expectations (17). Within the context of scientific research, a factor is labelled as a confounder if it satisfies two conditions and two restrictions (39). Firstly, the factor is a cause of the disease, or a surrogate measure of a cause, in unexposed people; factors satisfying this condition are called risk factors. Secondly, the factor is correlated, positively or negatively, with exposure in the study population. If the study population is classified into exposed and unexposed groups, this means that the factor has a different distribution (prevalence) in the two groups. Thirdly, the factor must not be an intermediate step in the causal pathway between exposure and disease. Lastly, the factor must not be affected by the exposure (39).

Developmental Coordination Disorder:

The DSM-IV-TR defines Developmental Coordination Disorder (DCD) as deficits in the development of motor coordination, which are not due to a general medical condition or mental retardation (24).

DCD usually presents with neurological soft signs, such as hypotonia (low muscle tone), persistence of primitive reflexes and immature balance reactions that affect motor development (40, 41). Muscle weakness, ataxia and abnormally low muscle tone or abnormally high muscle tone are inconsistent with DCD diagnosis (4). Wegner suggested that DCD is not characterised by focal brain abnormalities and consequently, magnetic resonance imaging and computed tomography cannot be used for diagnosis (42).

Numerous names have been given to this condition of impaired coordination, including dyspraxia, developmental dyspraxia, clumsy child syndrome, sensory integration disorder and even minimal brain damage (43, 44). DCD gradually replaced the terminology from 1992 (43) and is the preferred medical term that will be used in this document.

The DSM-IV-TR (24) does not specifically associate DCD with ADHD, though studies have found that the two disorders co-occur in 50% of cases (45-47). ADHD and DCD appear to be linked through a shared, additive genetic component (48). According to Piek, Pitcher and Hay (49), children with DCD who present with fine motor deficits are linked to the subtype ADHD-PI. Children diagnosed with DCD commonly have learning disabilities, emotional problems, conduct disorder, and oppositional defiant disorder (50) and children with concomitant DCD and ADHD are particularly at risk for these problems (6).

Fine Motor Skills

Fine motor skills refer to the use of the small muscles of the hands and fingers for tasks such as cutting and colouring (1). Fine motor skills develop more slowly than gross motor skills (1).

Four-To-Six-Year-Old Children:

This age group falls under early childhood development and can be classified as the preschool period within the South African context (51). The preschool years are characterised by striking physical and psychological changes (2). In this study the terms “preschoolers”, “preschool children”, “grade R learners” and “four-to-six-year-old children” are used interchangeably.

Grade R:

Grade R refers to reception year, preceding grade 1 (52).

Gross Motor Proficiency (see Motor Proficiency):

Gross motor proficiency refers to a state of being skilled or competent in large muscle group movements (10). In this study, the focus was more on the performance of balance skills, locomotion and ball skills which are categorised as gross motor skills.

Gross Motor Skills:

Gross motor skills require the coordination of the large muscle groups of the body (1). Skill in this area requires consistency in achieving a motor goal with economy of effort (53). Examples of gross motor skills are balancing, climbing, catching, galloping, hopping, jumping, kicking, running, stepping, and throwing.

Hypotonia/Low Muscle Tone:

The term hypotonia is often used to describe children with low muscle tone (54). When discussing low muscle tone it is necessary to differentiate between muscle weakness and hypotonia. If joints are moved passively, a child with hypotonia will present with reduced resistance to the passive movement, while muscle weakness is a lack of muscle strength or a reduction in the maximum power that the muscle can produce (55). Functionally, hypotonia presents as a difficulty to maintain postural control and body positions against the pull of gravity (55).

In a study in the USA physical and occupational therapists were asked to list the characteristics of hypotonia (54). The reported characteristics were: decreased muscle strength, decreased activity tolerance, delayed motor skills development, rounded shoulder posture with leaning onto supports, hypermobile joints, increased flexibility, and poor attention and motivation. Jan points out however, that hypotonia might exist with normal muscle strength, such as in children with Down syndrome (56). Diagnoses associated with hypotonia are Down Syndrome, Cerebral Palsy, Autism/Pervasive Developmental Disorder, Developmental Delay and Sensory Integration Dysfunction (54).

Inhibitory Activitiy:

An inhibitory activity, in the sensory integration frame of reference, refers to a sensory experience which decreases the level of alertness. In other words, when a child is feeling overexcited, hyperactive or hyped-out, the sensory experience is calming in nature (9).

Intervention research:

Intervention research is defined as the methodical study of strategies designed to bring about change (57, 58). Intervention research emphasises the design and development of new interventions which is relevant to this research project. Alternatively, evaluation research focuses on existing programmes (57).

Just Right Challenge:

The concept "just right challenge", inspired by Ayers (59, 60), in the sensory integration frame of reference, refers to an activity that adjusts to the child's current level of function while promoting new skills and abilities (31). Creating the just right challenge requires taking the child's skills and interest into account in combination with an activity analysis (60).

Mediator Variable:

In statistics, a mediator variable clarifies the relationship between independent and dependent variables (17), whereby the independent variable causes the mediator variable, which in turn causes the dependent variable (61).

Motor Control

Motor control refers to the ability to regulate or direct the mechanisms essential to movement (31). These mechanisms are found in the person, in the task's demands and in the environment (31).

Motor Development:

Motor development refers to the process of motor behaviour changes over the lifespan (31) and is an important aspect of physical development in the child (1). The growth of the body and internal structures accompanies the gradual improvement of control over the body and body movements of the child (1). Motor performance is the product of development and maturation, as well as the influence of genetics, body dimensions, environment, motivation, experience, practice and expectations (31).

Motor Proficiency:

Motor proficiency consists of two separate and distinct components: motor abilities and motor skills (19). Motor abilities are underlying, genetic-based, capabilities that are stable and not easily improved (19), but can be changed through development and growth. Motor skills are also referred to as fundamental movement skills or childhood movement skills, and are modifiable through practice and experience (19) .

Motor proficiency, in terms of motor abilities and motor skills, consists of gross motor skills and fine motor skills (19). Most researchers (the current study included) are interested in motor skills in regard to motor proficiency as the development and maintenance of motor skills are likely to be impacted by intervention programmes. Intervention programmes are unlikely to change motor abilities (19).

Overweight/Obesity

Overweight/Obesity is defined as “an imbalance between energy intake and expenditure such that excess energy is stored in fat cells, which enlarge or increase in number” (62). The 95th percentile is considered obese for people 20 years and younger. People younger than 20 years with a BMI between the 85th and 95th percentile are considered to be overweight, according to WHO criteria (33, 63).

Perinatal Morbidity:

Perinatal morbidity is defined by the Australian health care committee expert panel on perinatal morbidity (64) as a disorder in the neonate, child or family which occurs as a result of adverse influences or treatments acting either on the foetus during pregnancy and/or the infant during the first four weeks of life. Conditions such as pre-term birth, perinatal asphyxia, intrauterine growth restriction, perinatal infections, as well as congenital malformations, are associated with perinatal morbidity (64).

Physical Activity:

Corban defines physical activity as "bodily movement that is produced by the contraction of skeletal muscle which substantially increases energy expenditure" (65). Exercise, sport, walking, dance, as well as other movement forms are examples of physical activity (65).

Play:

The term play is defined as engaging in an activity for recreation and enjoyment rather than for practical or serious purposes (17). From an occupational therapy perspective, play is described as any activity freely entered into for enjoyment or fun that is appropriately matched to the child's skill to represent a realistic challenge (66).

Postural Control:

Postural control involves controlling the body's position in space for the dual purposes of stability and orientation (67) and forms the foundation for fluid, controlled movement (31). It is dependent on adequate muscle tone, the ability to activate muscle synergies, co-activation of muscles, together with effective integration of sensory information from the vestibular, proprioceptive, visual and tactile systems (31).

Preterm Birth/Low Birth Weight:

Preterm birth occurs when a child is born at less than 37 completed weeks or 259 days of gestation (68). In the past, a birth weight of less than 2500 grams was classified as preterm (69). Currently, however, it is known that poor intrauterine foetal growth could result in a full-term infant with a low birth weight (69). Therefore, low birth weight is not synonymous with preterm delivery. However, due to the association of very low birth weight with increased infant morbidity and mortality, all babies born at term gestation or prematurely are classified according to weight (70).

Running Speed:

Running speed refers to the child's speed during running (30). Age-appropriate running speed requires adequate balance and postural control for smooth, controlled movement (31).

Self Regulation:

Self-regulation is the ability to regulate and maintain attention/focus, arousal level and activity level that are appropriate for the demands of the task at hand (31). Effective sensory discrimination, modulation and integration is needed for adequate self-regulation, which is closely linked to attention, activity level and arousal regulation (31).

SEMOSTI Programme:

This sensory-motor stimulation programme was designed by the researcher and is the second draft of the Grade R Programme. The SEMOSTI Programme was developed to be implemented by teachers in the grade R classroom within a group setting. The programme spans a school year, or forty weeks, and includes activities that are presented over a five-day cycle. The duration of each day's activities is about 45 minutes and includes an Alert section, two Just-Right challenges and a Calming period.

Sensory-Motor Development:

Sensory-motor development, in the sensory integration frame of reference, refers to the relationship between sensory processing and integration and motor function (71). Sensory skills are those such as vision, hearing, and touch. They are responsible for receiving information. Motor skills relate to muscles and movement. Motor skills give expression to the information our senses receive and process (71). The SEMOSTI Programme was designed to stimulate underlying sensory-motor development by providing bodily sensations (mainly through alert and calming activities) and experimenting with and practicing motor movements (just-right challenges).

Strength:

Strength is defined as the muscular force used to perform activities (19). The term strength in this study refers to physical power and endurance of the large musculature of the arms and shoulders, abdominal muscles and legs combined (30). Increased strength contributes to well-coordinated running and jumping as the child develops (10).

Type 2 Diabetes:

Type 2 Diabetes is a type of Diabetes mellitus, which is a diverse group of metabolic disorders with varied clinical characteristics united by hyperglycaemia (72). Type 2 Diabetes is defined as insulin resistance and relative insulin deficiency (73). Although the propensity for this disease is mostly inherited, it is often triggered by lifestyle factors such as high blood pressure, poor nutrition, excess weight and insufficient physical activity (73). Type 2 is the most common form of diabetes, which affects 85-90% of all people with the disease and is more common among older people with 46 to 52 years being the average age at diagnosis (73).

Upper-Limb Coordination:

Upper-limb coordination refers to precise movements of the arms, hands and fingers, as well as coordination of visual tracking with movements of the arms and hands (30). Upper-limb coordination functionally translates into ball skills, but includes any tasks requiring coordinated arm and hand movement with visual tracking, such as pouring juice from a jug into a glass (10).

1.6 SIGNIFICANCE AND CONTRIBUTION OF THIS RESEARCH

Intervention research consists of five steps (57). The process starts at defining a problem and developing programme theory. Next the programme is designed through specifying the structures and processes and creating manuals. This is followed by efficacy and effectiveness tests to confirm if the intervention is valid and reliable. Lastly, the research findings and programme materials are published (57).

The SEMOSTI Programme is a newly designed intervention strategy based on the evaluation and revision of the Grade R Programme. The problem has been defined; programme theory was developed; the programme was designed and a manual was created (section 2.5) (57). This study was the next step in the programme‘s development by pilot testing the feasibility of the SEMOSTI Programme and testing if the programme was potentially effective.

This study aimed to provide valuable information needed to refine the SEMOSTI Programme’s content, structure and manual. If the programme was found beneficial, further development could be considered that would lead to efficacy and effectiveness tests, after which the SEMOSTI Programme could be offered to other schools as a useful tool for grade R.

In this study, factors that are associated with the development of motor proficiency in children, such as gender, perinatal morbidity, body mass index and physical activity, were taken into account. Results related to these factors could benefit other therapists and educators to optimise intervention strategies for enhancing sensory-motor development.

1.7 SCOPE AND DELIMITATION OF THIS RESEARCH

1.7.1 Scope in Occupational Therapy

This study is applicable to the field of paediatric occupational therapy. The focus is on play occupations of four-to-six-year-old children as they tend to engage in very active play (10). The intervention strategy focuses on sensory-motor skills while this study is demarcated to gross motor skills.

This study and the SEMOSTI Programme fall within the occupational therapy practice framework of health promotion and prevention of disability (74). Occupational therapy's focus on the health effects of purposeful and meaningful occupation results in an important role in the area of health and wellness. This intervention aimed to provide skill development training on a community/population level (pre-school).

1.7.2 Representation and Compliance

Data collection took place at six grade R classes at two mainstream schools in Gauteng province of South Africa. A sample of 73 participants was selected, individually assessed twice during the school year, and data was analysed. Due to limited resources and the hands-on nature of the study, this research could only be conducted on a limited sample. The results, therefore, are context-bound and specific to the four-to-six-year-old children who participated in the study.

Furthermore, the study is demarcated to the impact of the SEMOSTI Programme on the development and maintenance of gross motor skills and does not include sensory aspects or fine motor skills. Due to time constraints only some aspects of gross motor skills were measured in this study. Section 2.6 discusses the selection of the following gross motor skills, namely bilateral coordination, balance, running speed and agility, upper-limb coordination and strength.

This study is a pilot-test of the SEMOSTI Programme to test the feasibility and potential effectiveness of the intervention. It is demarcated to step two of the intervention research process (57) before efficacy and effectiveness tests have been conducted.

The results depended on the compliance of the grade R teachers at the experimental school to present the SEMOSTI Programme accurately and daily according to the manual. Fidelity measures (see section 3.6.1) were put into place to ensure accurate implementation, however some teachers may not have adhered to the manual.

1.7.3 Application to Other Fields

Grade R educators may benefit from the results of the study. The results could provide them with valuable information regarding the potential use of the SEMOSTI Programme as a tool in the classroom.

1.8 LAYOUT OF THIS RESEARCH

The research document contains the following chapters:

Chapter 1: Gives an introduction and background to the research project.

Chapter 2: Presents a literature review on the following topics:

- The need for a sensory-motor stimulation programme
- Impact of delayed sensory-motor development on children

- Grade R in South Africa
- Intervention strategy (the design and development of the SEMOSTI Programme)
- Selection of five gross motor skills
- Measurement instruments

Chapter 3: Describes the methods selected for researching the problem.

Chapter 4: Contains the findings of the research and analysis of data.

Chapter 5: Contains the discussion, conclusions and recommendations that the researcher reached through this project.

1.9 CHAPTER SUMMARY

The SEMOSTI Programme was developed as a strategy to enhance sensory-motor proficiency in grade R learners to meet a need that was identified by a public primary school. Nevertheless, evidence was needed to support the use of the stimulation programme; as such a programme had not been published or researched within the South African context. This study met this need by exploring the impact of the SEMOSTI Programme on the development and maintenance of gross motor skills in four-to-six-year-old children.

In this chapter the main idea for the research was discussed, the background that led to this project was described, the aim and objectives, as well as the concepts used in the research were clarified and the significance and limitations of this project were explained. An outline of each chapter with the main idea and logical sequence was also provided.

Chapter 2 focuses on literature describing current trends in society and incidence of pathology that influence the development of children's gross motor proficiency. The impact of delayed sensory-motor development on children is discussed and the current policies and practices regarding grade R in South Africa is examined. The design and development of the SEMOSTI Programme are discussed in terms of the intervention research steps. The selection of the five gross motor skills, tested in this study, is motivated. Lastly, the measurement instruments are reviewed.

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides an in-depth review of literature relevant to motor proficiency in four-to-six-year-old children, various factors associated with gross motor proficiency and the development of the SEMOSTI Programme. Six topics are addressed:

Firstly, the need for a stimulation programme will be explored by reviewing the impact that current trends in our society have on the sensory-motor development of children. This includes an in-depth discussion on physical activity and incidence of pathology resulting in delayed sensory-motor development. Secondly, the impact of delayed sensory-motor development on the areas of occupation of a child will be identified and discussed, highlighting the far reaching implications of this problem. Thirdly, the current policies and practice regarding grade R in South Africa will be examined to highlight the need for specific tools and programmes to guide teachers. Fourthly, the development and design of the SEMOSTI Programme will be analysed and critically evaluated. The theoretical foundation and principles that guided the development will be discussed. Fifthly, the selection of the five gross motor skills, on which this study focused, is motivated. And lastly, the measurement instruments used in this research project will be reviewed in terms of their validity and reliability, including an explanation for the choice of instruments used in the study to measure gross motor proficiency and physical activity. The chapter ends with a summary.

2.2 THE NEED FOR A SENSORY-MOTOR STIMULATION PROGRAMME

As stated in chapter 1, the principal of a public school expressed the need for a gross motor stimulation programme for grade R classes. The need expressed by the principle and teachers at the school is based on their personal experience. This need is reinforced by extant literature regarding the increase in gross and fine motor difficulties in children.

Another possible explanation of an increase in gross and fine motor difficulties in children is that teachers today are better informed regarding motor development. Teachers have access to more resources such as school-based occupational therapy services, school-based educational psychology services and access to the World Wide Web. Through access to more information regarding motor development, teachers might be more aware of children's motor performance and consequently more aware of motor difficulties. Thus, it might rather be the case of increased awareness among teachers than a true increase in the number of children with motor difficulties.

Research has not been conducted at South African schools to investigate whether more children present with motor difficulties today than in previous years. However, extensive international research has been done on factors influencing children's motor development, especially in the USA and Europe. Although the populations are not identical to South Africa, the study population might be similar in terms of income, parental education, health and nutrition (discussed in section 3.4). Therefore the literature, although based on international studies, is believed to be of value in the context of this study.

Caniato, Stich and Baune (75) studied the rates of motor impairment in pre-school children over a period of thirteen years in Bavaria, Germany. Their results indicated a rapid and dramatic increase in motor problems, especially fine motor and graph-motor (drawing) skills, over the years (75). They concluded that patterns of motor skills in children are changing. These changes might be natural and predictable to a changing technological world or, alternatively, might indicate a serious and pathological change in childhood development (75).

Various social, environmental, technological or biological factors could be responsible for changes in patterns of motor skills which warrant intervention. However, this discussion will focus on the prominent issues that were identified while reviewing scientific literature. Extant literature indicates a decrease in the physical activity of children (11) and an increase in pathology (11, 75, 76), resulting in delays or difficulties with sensory-motor development in children.

These two issues will be discussed in more detail below. The discussion firstly indicates causes of increased gross and fine motor difficulties in children. Secondly, the discussion identifies variables that need to be taken into account as possible confounders in this study.

2.2.1 Decreased Physical Activity

Children are inherently active beings (77), but despite this inherent characteristic, physical activity is declining among South African children and young people in urban areas (11). The most vulnerable groups affected by this decline are children of all ages from disadvantaged communities and girls aged between sixteen and nineteen years (11). This decline in physical activity has caused a heightened awareness. Recently, more countries worldwide, including South Africa, have realised the significance of physical activity and proper nutrition, resulting in research exploring the impact of these elements on the development and general health of children (78, 79).

The National Youth Risk Behaviour Survey describes self-reported data on the activity levels of South African children and youth (80). The results of the survey indicated that one-third of the children partake in lacking or no moderate-to-vigorous activity on a weekly basis. Furthermore, one-quarter of the youth surveyed stated that they spend more than three hours per day in front of the television (80), with the average time for sedentary activity reported as nine hours per day (80). This trend was also found in smaller towns and rural areas where 64% of girls and 45% of boys participate in insufficient or no moderate-to-vigorous activity (80).

The South African Nutrition Expert Panel (SANEP) conducted a study in 2005 and found that modern South African families lack a balanced lifestyle (81). Instead, there is a tendency of both parents to work, arriving home late, and resting over weekends with little activity. As a result, their children tend to spend significant time on their own, participating in more sedentary activities, such as playing computer games and watching TV. Their tired parents often choose to join the children in TV viewing instead of being physically active due to being too exhausted. This behaviour encourages the formation of unbalanced lifestyle patterns in children (81).

The SANEP study also identified a lack of safety in South Africa affecting children's ability to play and be active in streets and in the parks (81). It may be that other factors, such as living in a flat or informal settlement, poverty, health, poor nutrition or technology might also contribute to unbalanced lifestyles in modern South African families. However, these factors were not investigated in the SANEP study (81).

Findings of the SANEP study also indicated that physical education in South African schools was receiving much less attention at the time of the study than in previous years (81). This suggests that children are less active and the educational government is doing less to improve matters. The situation, however, is currently changing with recent reports that the Department of Education compiled a Draft School Sport Policy for Public

Schools in South Africa (82). This policy states that the provision of physical education for learners from reception to grade 12 is compulsory as a component of the Life Orientation curriculum (82). Weekly physical education periods should be offered providing 45 minutes per week for grades 4 to 7 and 60 minutes per week for grades 11 to 12 (82).

While this school sport policy is a step in the right direction, there is also criticism against it for not specifying physical education periods or programmes for learners from reception to grade three (Foundation Phase) which focus on the development of skills or potential (82). The policy mainly focuses on increasing the learner's participation in school sport, although competitive sport is not encouraged in the Foundation Phase (82). Added to this shortcoming, there is a decline in the number of specialist physical education teachers that are trained to implement this policy (11).

While research has demonstrated the decline in physical activity in South African children (11, 80, 81), there is a similar international trend. The Canadian Community Health Survey (CCHS) of 2000-2001 reported that more than 50% of youth aged twelve to nineteen are physically inactive (78). Further, the Canadian Fitness and Lifestyle Research Institute (CFLRI) estimated that 82% of youth is not active enough to meet international guidelines for optimal growth and development (78).

Studies conducted on youth in the USA also demonstrated these trends. Boreham and Riddoch (79) argue that children are more inactive in recent decades and expend approximately 600 kcal/day less than children 50 years ago. Salmon and Timperio (83) indicated that estimates of the number of children and youth meeting current physical activity recommendations are scarce. Trends suggest declines in population-level physical activity among children, in particular declines in active transport and school physical education (83).

A national survey was conducted in the USA among students from grade 9 to 12 in 2007 (38). Of the students surveyed, only 34.7% met recommended levels of physical activity (38). Only 53.6% attended physical education classes on one or more days in an average week when they were in school, compared to 30.3% of students who went to physical education classes 5 days in an average week when they were in school (38). Of the students surveyed, 24.9% participated in screen viewing for 3 or more hours per day on an average school day (played video or computer games or used a computer for something that was not school work) while 35.4% watched television three or more hours per day on an average school day (38). These results demonstrate that decreased physical activity among children and adolescents seem to be an international trend, and not specific to South Africa.

Impact of decrease in physical activity on the development of children on a sensory-motor level

Children need to be physically active to develop and grow optimally (84). Through physically activity, children develop sensory-motor, cognitive and socio-emotional abilities and experience a sense of psychological well-being (85-87). Wrotniak, Epstein, Dorn, Jones and Kondilis linked increased physical activity to increased motor proficiency, whereas increased sedentary activity is linked to decreased motor proficiency (12). Furthermore, studies show that physical activity could significantly improve motor skills (88, 89) and a decrease in physical activity may result in difficulties in the development of these motor skills (90). It is possible that a decrease in physical activity in children will also lead to delays or problems with sensory-motor skills, but research in this area is lacking. Therefore, physical activity is taken into account in this research study.

2.2.2 Increased Pathology

Survey data collected during this project in addition to clinical experience and scientific literature revealed a list of common disorders/diseases from which mainstream South African grade R children suffer: Overweight/Obesity; Diabetes; Asthma; Attention Deficit Hyperactivity Disorder (ADHD); Developmental Coordination Disorder (DCD); Hypotonia/low muscle tone and Preterm Birth/Low Birth Weight. The conditions that are directly related to sensory-motor development will be discussed below. Each condition will be explored below in terms of if it is an increasing problem among young children and whether it affects a child's development on a sensory-motor level.

2.2.2.1 Overweight/Obesity

Obesity is increasing globally with 22 million children younger than five-years-old classified as overweight (63). Wang and Lobstein reported an increase in obesity in most countries with exceptions among school-age children in Russia and Poland during the 1990s and among infant and pre-school children in some lower-income countries (91). Economically-developed countries and urbanised populations showed a marked increase where the prevalence of overweight or obesity in school-age children doubled or tripled (91).

Ogden, Troiano, Briefel, Kuczmarski, Flegal, and Johnson (92) conducted a study in the USA to explore the occurrence of overweight preschool children from two months to five years of age between the years 1971 through 1974 and 1988 and 1994. The results indicated that the number of overweight children among four-and five-year-olds increased over the last 20 years, but an increase was not found among children younger than four years old (92). This is a demonstration for a need among children four years and older (92) for early prevention through the encouragement of physical activity and improved nutrition.

A similar trend was reported in South Africa in the National Household Food Consumption Survey (76). Findings indicated that within urban areas 17.1% of children between the age of one and nine were overweight (76). In addition, the Youth Risk Behaviour Survey (n=9054), conducted in 2002 with public school learners over nine provinces, found that over 17% of adolescents were overweight, and 4.2% were obese (80). Taken together, the extant research demonstrates that obesity and overweight are an increasing problem among children in South Africa and around the world.

Impact of overweight/obesity on the development of children on a sensory-motor level

Studies indicate that overweight/obesity affects a child's development on a sensory-motor level, specifically gross motor skills, fine motor skills, postural control and endurance performance (93-96). D'Hondt, Deforche, De Bourdeaudhuij and Lenoir (93) found that overweight and obese children specifically performed worse in fine motor tasks in standing and in sitting compared to their typical weight peers, indicating possible underlying perceptual-motor coordination difficulties. Graf, Koch, Kretschmann-Kandel, Falkowski, Christ, and Coburger (94) found that the overweight/obese children also performed worse in gross motor tasks and running than typical and underweight children.

A study conducted to compare the physical activity of overweight and non-overweight three-to-five-year-olds during the preschool day (97) showed that overweight boys were significantly less active than their non-overweight peers, but no significant differences were observed in girls (97). As previously, noted, motor proficiency is positively associated with physical activity (12), so it can be concluded that overweight boys specifically may have problems with motor proficiency.

It appears that overweight/obesity might be positively associated with a poor motor proficiency (93-96), but that it needs to be further supported with evidence. As such, overweight/obesity is taken into account in this research study.

2.2.2.2 Type 2 Diabetes

Type 2 Diabetes is increasing among children and adolescents (62, 98). In the USA a longitudinal study among 1,027 adolescents found that between 1982 and 1994 the incidence of Type 2 Diabetes increased tenfold among certain ethnic groups, partly due to obesity and family history (62). Another study showed that Type 2 Diabetes has become increasingly common among children aged six to eleven years and adolescents aged twelve to nineteen years in the USA (98). The American Diabetes Association reported that the diagnosis of Type 2 Diabetes typically occurs between the ages of 10 and middle-to-late puberty (99). With the increase of childhood obesity, diagnoses may begin to occur in younger children (99). Data about the incidence of Type 2 Diabetes among South African children is not available (100).

Impact of Type 2 Diabetes on the development of children on a sensory-motor level

Empirical findings related to the impact of Type 2 Diabetes on the sensory-motor development of children are lacking because the condition is more common in older people (73). Experts on diabetes in children reported that 85% of children diagnosed with Type 2 Diabetes were overweight or obese (73) which appears to affect the child's development on a sensory-motor level. However, the association between physical activity and type 2 diabetes needs further investigation.

2.2.2.3 Asthma

Studies indicate that the prevalence of asthma in children has increased in many countries over recent years and is often under-diagnosed and under-treated (101). Akinbami (23) reports that after a large increase in the presence of asthma amongst children from 1980 to the late 1990's, they are now at the highest levels they have been in the USA. Specifically, cases among children, from birth to seventeen years-old, more than doubled from 3.6% to 7.5% by 1995 (23).

The 'Chestiness in Childhood Asthma in Mitchell's Plain' (CHAMP) study is the only local research found to investigate the prevalence of asthma in pre-school children (101). The study reported that children between the ages of two-to-six-years presented with a high incidence of asthmatic symptoms, with 36.7% reporting wheezing in the past 12 months (101). The pre-school age group had more asthma diagnoses (13.1%) than in the school-going group (11.2%). The statistics in pre-school children reported for South Africa proved slightly higher than in the United Kingdom (102), but much lower than Australia (103). Several factors are associated with the development of asthma, but research has not proved a causative agent (23).

Impact of asthma on the development of children on a sensory-motor level

It appears that asthma might indirectly affect a child's development on a motor level. Lang, Butz, Duggan and Serwint (104) reported that school-going children living in urban areas presented with lower physical activity than their peers and that 20% of children suffering from asthma participate in insufficient physical activity. The disease severity and parental health beliefs influenced the activity level of children with asthma (104). As previously noted, motor proficiency is positively associated with physical activity (12).

2.2.2.4 Attention Deficit Hyperactivity Disorder

Brown suggested that various factors affected the incidence rates across studies of ADHD in the USA, including gender, setting (community versus school) and diagnostic nomenclature (DSM-III versus DSM-III-R criteria) (105). The average incidence rates of ADHD were higher among males (9.2%) compared to females (3.0%), higher in community samples (10.3%) compared to school samples (6.9%), and higher among children who were diagnosed according to DSM-III-R criteria (10.3%) compared to DSM-III criteria (6.8%). The prevalence of ADHD also varies with age. Three studies reported decreases in prevalence with increasing age (106-108)

New Zealand, Canada, Germany, and the United Kingdom all reported overall ADHD prevalence rates of 3% to 7%, which is similar to the United States (109). The American Academy of Paediatrics estimated a prevalence rate of 4% to 12% among six-to-twelve-year-olds (110) and this number is rapidly increasing. The US National Ambulatory Medical Care Survey indicated that over a period of eight years, from 1990 to 1998, the prevalence of ADHD diagnosis increased by 250% (111).

Kelleher, McInerny, Gardner, Childs and Wasserman (112) found that paediatricians identified ADHD disorders in 9.2% of children in 1996, compared with only 1.4% of children in 1979. This demonstrates that the increase in ADHD cases may indicate an increased awareness or better screening and/or an actual increase in the number of children born with the condition.

According to the most recently published data, approximately 8% to 10% of the South African population have ADHD (77). Aase, Meyer and Sagvolden (113) reported that the prevalence of ADHD in the Limpopo Province, specifically, was similar to those reported in Western countries, suggesting that ADHD is a basic neurobehavioral disorder and not a cultural phenomenon.

Impact of ADHD on the development of children on a sensory-motor level

Extant research indicates a correlation between ADHD and motor proficiency (114). A study conducted on the fine motor skills of South African children with symptoms of ADHD, found that ADHD impacted complex motor tasks in terms of accuracy and speed (114). However, it did not have an impact on the speed of simple motor tasks. Fine motor skills were more severely impacted on by the subtype ADHD-C. In another study, however, the subtypes ADHD-PI and ADHD-C performed significantly poorer in fine motor tasks than in the control group (115). Difficulties with fine motor skills have also been associated with hyperactivity symptoms (116).

Children with ADHD symptoms have difficulty in several motor areas, specifically fine motor skills, poor timing of motor responses and motor overflow persistence (116). D'Agati defined motor overflow as movement of various body parts that is not expressly needed to efficiently complete the task (117).

Tseng, Henderson, Chow and Yoa (118) investigated the relationship between motor proficiency, attention, impulse and activity in children with ADHD and found that their gross motor skills were poorer with greater activity levels. Previous studies have also associated motor coordination deficits with hyperactivity (115,119,120). Taken together, these findings indicate that decreased motor proficiency may be due to inattention, poor impulse control, hyperactivity, and not primarily a motor deficit (118). Alternatively, decreased motor proficiency might be caused by or co-occur with problems in attention, impulse control and activity level (118).

2.2.2.5 Developmental Coordination Disorder

In the past few years, there has been an increase in the recognition of Developmental Coordination Disorder (DCD) as a common problem (121) but data are not available to indicate whether the incidence of DCD has increased in South Africa or globally.

Epidemiologic studies indicate that 5% to 15% of school-aged children are affected by significant clumsiness, however, an estimate of 6.4% is more valid (122,123). Boys are often more affected by significant clumsiness than girls (50). The child's level of education or socio-economic status is not related to the incidence of DCD (122). Diagnosis rarely occurs before the age of five, usually occurring between the ages of six and twelve years (122).

Wessels, Pienaar and Peens (124) conducted a study in South Africa on a diverse population to investigate gender and racial differences in six-to-seven-year-old children with DCD in learning-related abilities and ADHD. The results showed no significant racial differences in six-to-seven-year-old children with DCD although young black children had more numerical and verbal comprehension problems than their non-black peers (124).

Impact of DCD on the development of children on a sensory-motor level

DCD affects a child’s development in three areas: gross motor, fine motor and psychosocial skills (40). Children diagnosed with DCD usually have difficulty following two-to-three step motor commands, present with a clumsy running pattern, fall often, frequently let objects fall and have difficulty copying body positions (125). They also have difficulty with simple motor tasks such as running, jumping or navigating stairs (4).

Fine motor development is another area of difficulty for children diagnosed with DCD, including drawing and writing skills (126). They frequently have difficulty planning and executing other tasks such as gripping, buttoning and dressing (126,127). Smyth argued that children with these difficulties may experience emotional problems (125). They may have problems making friends and fitting in with peers (128).

Faught, Hay, Cairney and Flouris (129) investigated the possibility of an increased risk of coronary vascular disease in children with DCD and found that children with DCD tend to be less physically active, which may play a role in obesity and poor physical fitness. Tsiotra, Flouris, Koutedakis, Faught, Nevill and Lane (130) supported this finding, reporting that children with DCD present with reduced physical activity. They argued that differences in lifestyle between Canadian and Greek children contributed to the significant differences in DCD rates between the two samples (130). A significantly higher prevalence rate of DCD was found among Greek children and Greek children tend to be less physically active. As previously, noted, motor proficiency is positively associated with physical activity (12).

2.2.2.6 Hypotonia/Low Muscle Tone

There is little to no data on the prevalence of hypotonia in children, as hypotonia is rather a symptom that is part of a diagnosis (54). Polzin is of the opinion that the incidence of hypotonia is increasing due to the increased survival of premature infants who are then at risk of neurological problems (131), but this argument requires further investigation.

Impact of hypotonia on the development of children on a sensory-motor level

Hypotonia is characterised by delayed motor development (54) and therefore, may affect the development of children on a sensory-motor level, depending on the severity of the condition. A study by Parush, Yehezkehel, Tenenbaum, Tekuzener, Bar-Efrat/Hirsch and Jessel (132) showed that children aged six-to-eight-years who were diagnosed with benign congenital hypotonia as infants, scored significantly low on gross motor proficiency, especially bilateral coordination and strength (132). Thus, findings indicate that hypotonia impacts sensory-motor development.

2.2.2.7 Preterm Birth/Low Birth Weight

In developed countries, preterm birth rates of 5% to 7% have been reported, with higher rates in developing countries (68) and these rates appear to be increasing (128). Preterm birth rates some developed countries specifically, such as the United Kingdom, the United States and the Scandinavian countries, show a dramatic rise over the past 20 years (68). Africa and North America reported the highest preterm birth rates of 11.9% and 10.6%, respectively (68). The lowest rates occurred in Europe, where 6.2% of the births were preterm (68, 68). In South Africa, premature births are on the rise with a current rate of 14% of all live births (70). According to the 2006 Health Statistics, the low birth weight rate for South Africa was 15.5% of all live births (133).

Possible factors in the increase of these conditions are greater use of assisted reproduction techniques, increasing rates of multiple births, and increases in the proportion of births among women over 34 years of age (68). Changes in clinical practices, such as greater use of elective caesarean section, could also contribute to the increased prevalence of premature birth (68).

Impact of preterm birth/low birth weight on the development of children on a sensory-motor level

Of children born between 32 and 35 weeks gestation, 33.3% may present with motor difficulties such as problems with writing, fine motor skills and physical activity (134). Other schooling difficulties include problems with mathematics, speaking and reading (134). Pre-term children tend to present with more behaviour problems such as ADHD characteristics (specifically attention deficits) compared with term-born children (135).

At age four, significant differences in motor function between preterm and full-term children could already be identified once motor skills matured (136). Between 2% and 30% of preterm children presented with delays in motor performance areas compared with term children (136).

Children with low and very low birth weight present with significantly lower levels of motor skills than normal birth weight children (137). Empirical data have shown that children are at increased risk of developmental delays associated with moderate preterm delivery or moderate low birth weight (138). Thus, there appears to be an association between preterm birth/low birth weight and gross motor proficiency, but more empirical data are needed for this argument. Preterm birth/low birth weight is taken into account in this study.

2.2.3 Summary

This section summarises the information addressed above and applies this information to the specific school investigated in the current study. Firstly, extant literature demonstrates global trends of decreased physical activity (11, 80) and increased pathologies (91) among children, which negatively impacts their sensory-motor development. Table 2-1 summarises the findings discussed in section 2.2. This implies that more children may experience sensory-motor difficulties than previously thought and may consequently benefit from strategies for sensory-motor stimulation.

Table 2-1 Summary of Findings Impacting Children's Sensory-Motor Development

	Is the prevalence increasing internationally?	**Is the prevalence increasing in SA?**	**Does it impact on the development of children on a sensory-motor level?**
Decreased physical activity	Yes	Yes	Yes
Overweight/Obesity	Yes	Yes	Yes
Type 2 Diabetes	Yes	Data not available	Weak association
Asthma	Yes	Yes	Weak association
ADHD	Yes	Yes	Yes
DCD	Data not available	Data not available	Yes
Hypotonia/Low muscle tone	Data not available	Data not available	Yes
Preterm Birth/Birth weight	Yes	Yes	Yes

Secondly, the discussion identified variables that needed to be taken into account as possible confounders in this study. The study's exclusion criteria addressed the effect of certain disorders/diseases on the results of the study. While factors, such as physical activity, overweight/obesity and preterm birth/birth weight were included in the data collection.

In summary, physical activity (12); is associated with motor proficiency. Children with lower levels of physical activity seem to present with poorer motor proficiency. Overweight/Obesity (139) is associated with motor proficiency. Children with higher levels of overweight/obestiy seem to present with poorer motor proficiency. Perinatal morbidity (136,140) is influenced by factors such as gestation, birth weight, pregnancy and labour and delivery. Premature birth and a low birth weight (136,140) is associated with motor proficiency. Children born with a shorter gestation period and/or low birth weight seem to present with poorer motor proficiency. Lastly, gender (2) impacts on gross motor proficiency. Landers (2) suggested that boys and girls develop differently physically. Similarly Hardy, King, Farrell, Macniven and Howlett (141) suggested that girls' locomotor skills are better developed than that of boys, while boys' object control skills are comparatively better developed. Therefore, these factores may adversely affect the relation between the SEMOSTI Programme and the participants' gross motor proficiency and consequently, were selected, measured and taken into account during data analysis (refer to section 3.6.3).

The next section explores the impact that delayed sensory-motor development could have on the areas of occupation of childhood namely, activities of daily living, school performance and play.

2.3 IMPACT OF DELAYED SENSORY-MOTOR DEVELOPMENT ON CHILDREN

During infancy and later childhood, motor activity plays a decisive role (1, 2), in the development of all occupation areas appropriate for the child's age. Various factors could prevent children from acquiring age-appropriate motor skills. In this regard, decreased physical activity and increased pathologies have been discussed above (section 2.2).

Research suggests that delays in sensory-motor development are not a benign delay that will be outgrown, but rather appear to persist into late adolescence, resulting in varying degrees of academic, social and emotional difficulties (6, 7,142). Therefore, sensory-motor delays are likely to result in the child not reaching his/her full potential. Consequently, it is important that affected children with sensory-motor delays be recognised and addressed early so that these problems may be avoided (142). As sensory-motor delay impacts the child's occupational performance and impacts activities of daily living, school performance and play, these areas of occupation will be discussed to emphasise the significance and far-reaching effects of sensory-motor delay.

2.3.1 Activities of Daily Living

Activities of daily living refer to daily self-care activities such as personal hygiene grooming, feeding, etc (10). The child's ability or inability to execute these activities is a practical measurement of the child's functional status (10). Sensory-motor delays make the accomplishment of daily living activities more difficult. Tasks such as dressing, eating, bathing and tooth brushing are impacted on due to difficulties with postural control and fine motor skills (143). Children with sensory-motor delays might need assistance for a longer period of time before being able to execute activities of daily living independently (10).

2.3.2 School Performance

Sensory-motor delays have a negative impact on school performance. Some early difficulties may present as poor pencil grip, poor scissors grip and difficulty cutting in a straight line (4), which typically lead to poor drawing and writing skills (3). Difficulties with coordination and motor speed may result in the child having difficulty keeping up with his or her peers in class (122). One study found that children with sensory-motor delays at the age of seven presented with difficulties in reading comprehension at the age of ten (121). Thus, children with sensory-motor delays might need extra time in class to complete tasks, might take longer to master skills and might benefit from more practice than their peers (122).

A child's sensory-motor ability plays an important role in the development of cognitive functions necessary for optimum school performance. This relationship was first investigated by Piaget (144) and since, has been explored further by many researchers (145). Bonifacci (44) distinguished between two main profiles of learning disabilities that may result from sensory-motor deficiency. The first profile includes problems in language abilities (44), which affects writing and reading (e.g., dyslexia). The second profile is related to arithmetic difficulties (44), possible linguistic difficulties and difficulties with motor component of writing and spatial problem solving. However, from a medical perspective, this second profile of motor impairment is termed DCD (44).

Clumsy children have been shown to present with deficits in proprioception and visual processing, resulting in difficulties integrating sensory information necessary for optimum school performance (7,127,146). One study demonstrated that children with impaired motor skills have a poorer visual–proprioceptive mapping ability in comparison with typically developed children (147). In particular, pre-school children with poor motor coordination presented with a significantly poorer kinaesthetic ability (148). Taken together, these results indicate that children with sensory-motor delays may suffer from various difficulties at school and therefore may benefit from adaptations, assistive devices and extra time to complete academic tasks successfully (10).

2.3.3 Play

Sensory-motor impairment also impacts the child's ability to play and socialise with other children due to poor ball skills and poor balancing and coordination necessary for tasks such as riding a bicycle or skipping (4, 5). Impairments in movement are accompanied by a variety of psychosocial problems, such as low self-worth and social isolation (5, 149). During a study of clumsy children's behaviour on the school playground (150), it was found that they spent more time alone, were onlookers more often, and played formal games in large groups less often if they were boys and informal games in large groups less often if they were girls. The two groups did not respond differently to social fantasy play, but they differed concerning social physical play (150). Children with significant movement problems have high levels of anxiety (151), which impacts on social and emotional development. Thus, children with sensory-motor delays might need assistance to make friends and participate in social physical play (10).

2.4 GRADE R IN SOUTH AFRICA

Having discussed the difficulties children with motor skills deficiency may face, this section will discuss the context in which the current study took place. Specifically, it will analyse the current policies and practices regarding grade R (receptive year) in South Africa and will highlight the need for proper training and developmentally appropriate tools for grade R teachers.

Grade R in South Africa consists of children with ages ranging from four to six years (52). The 2002 policy of the Department of Education state that learners can be admitted to grade R at the age of four years, but must turn five-years-old before the 30th of June in the year of admission (52). The average age for grade R learners in South Africa is five years turning six during the grade R year.

Currently grade R is being integrated into mainstream schooling, as 49% was community-based, 34% was home-based and only 17% was school-based in 2006 (51). This integration was initiated to ensure that all five-year-olds have access to grade R education. In 2008 there were an estimated 14 000 grade R classes countrywide where grade R programmes were provided to approximately 490 000 learners (152). In keeping with the thrust of transformation in education, both the White Paper 5 on Early Childhood Development (2001) (52) and the National

Curriculum Statement (52) envisaged the provision of quality grade R programmes to 1 million learners by 2010. Early Childhood Development (ECD) is an inclusive concept for the education of children from birth to nine years of age, which includes learners who are in pre-grade R programme, grade R programmes and Foundation Phase (grades 1–3) (51).

In summary, in 2006 the Department of Education formulated the following objectives regarding grade R, namely to incorporate grade R into the formal education system; to increase budgets to expand access to grade R; to introduce grade R teacher training programmes; to improve the provision of facilities through the Expanded Public Works Programme; and lastly, to make a grade R programme available to all five-year-old children by 2010 (51).

Though the number of programmes offered had begun to increase, statistics in 2007 showed that more than 20% of ECD centres that provide grade R schooling operated in conditions that were not conducive to learning (153). Only 12% of ECD teachers were trained, 88% were under-qualified and 23% were not qualified at all (153). One of the strategies of the Department of Education to transform education was by providing training programmes to grade R teachers (152).

In 2008 the Department of Education developed a document, Grade R Practical Ideas, to provide grade R teachers with an understanding of how to create stimulating indoor and outdoor play areas, how to manage the learning programme and give support for responsive interaction (152). This document suggests 15 to 20 minutes for music and movement and 20 to 30 minutes of outdoor physical play as part of a typical day programme (152). Unfortunately, except for some suggestions for gross motor equipment, the document does not focus on specific activities for the stimulation of sensory-motor skills which, highlights the need for specific tools and programmes to enable the teacher to stimulate the sensory-motor development in the four-to-six-year-old child in an age-appropriate and effective manner (152).

2.5 INTERVENTION STRATEGY

The evidence indicates that current trends impact today's children on a sensory-motor development level and that delayed sensory-motor skills have far-reaching effects on children's occupational performance of activities of daily living, school performance and play. The need for specific tools and programmes for grade R teachers in South Africa is apparent. Thus the next section is devoted to reviewing the design of the intended intervention strategy.

2.5.1 A Five-Step Model for Intervention Research

Fraser and Galinsky (57) formulated a five-step model of intervention research. The five-step model is rooted in work done by Rothman and Thomas (154). The intervention research process is not linear, as often new data leads to the return to an earlier step. This model was used as a framework for the design of the SEMOSTI Programme as an intended intervention strategy for the stimulation of sensory-motor skills in grade R learners. Figure 2-1 illustrates the steps in the design and development activities for intervention research (57, 155).

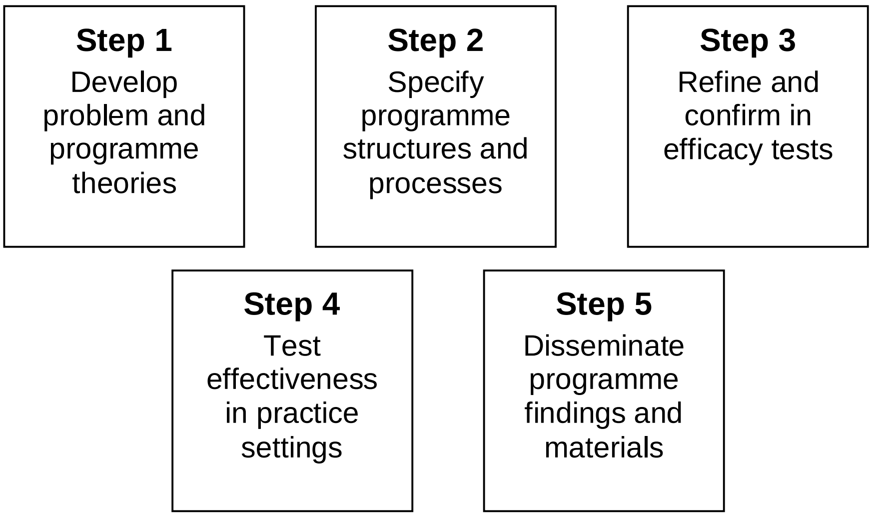

Figure 2-1 Steps in Intervention Research

The first step of intervention research (155) involves defining a problem and developing a programme theory. A programme theory refers to how the programme's actions are supposed to achieve the intended outcomes (61, 155). Programme theory should take risk, promotive and protective factors as well as mediators into account. The second step (155) focuses on the design of the intervention. This includes the implementation of principles and the creation of manuals (155). This step also involves the review of the draft and pilot testing for feasibility (155). Pilot testing is done to determine if the intervention is practical, reasonable, and potentially effective when implemented (57). The current study fits into this phase.

The third to fifth steps are not relevant to the current study as the SEMOSTI Programme is still in the process of being developed but the steps have been added for the discussion of future research. The third step focuses on the refinement of the intervention and manual and tests to see if the intervention has the desired outcome, called efficacy tests (155). Efficacy tests are research studies conducted under optimum conditions usually involving control and intervention groups, blinding procedures and placebos (155,156). Flay (156) stated that an efficacy test investigates a standardised treatment programme in a standardised setting to a specified target audience who fully complies with the programme. The programme is then modified and refined based on the results (156). Efficacy tests ensure that the programme does more good than harm when implemented under optimum conditions (156). Once the content of the programme is found efficacious, the fourth step will be to conduct effectiveness tests in practice setting (155). An effectiveness test is a test of an intervention in real-world conditions to see if it does more good than harm (156). Conditions in the real world refer to settings where there may be differences in the availability of the intervention, differences in the level of participation in the intervention or uncontrolled social and environmental effects, compared to optimum conditions when availability and acceptance are maximised. Findings would indicate if the intervention is still effective if other agents in a variety of settings implement it (156). The fifth and final step in intervention research, according to Fraser and Galinsky (155), is to publish the results in academic journals and publish the programme manual and materials for accessibility.

2.5.2 Application of Step 1 – Develop Problem and Programme Theories

The problem for the current study was defined as that the number of primary school children, at a specific school, who experience gross and fine motor difficulties were on the increase as discussed in chapter 1. Section 2.2 investigated the need for sensory-motor programme extensively and found that global trends of decreased physical activity and increased pathologies are impacting negatively on children's sensory-motor development.

Consequently, an intervention strategy was designed to address this problem, named Grade R Programme. The following key features of the intervention were based on the needs of the school as follows:

- Activities would be presented by each of the three grade R teachers to their specific class.
- Activities had to be presentable in the classroom setting or on the school grounds. The school had a big classroom for each grade R class. The school also consisted of a school hall, a rugby field, two netball courts, tennis courts and various grass covered open spaces. Activities could be presented in any of these spaces.
- The programme had to focus on gross motor activities appropriate for four-to-six-year-old children.
- It had to be user-friendly, using laymen's terms and had to be well-structured for teachers to present it with confidence and ease.
- The activities would be presented to groups of approximately 25 children.
- It had to run daily for 45 minutes over the school year (40 weeks).

- Only affordable and easily accessible equipment had to be used. Each grade R class already had the following equipment available: hula-hoops; beanbags; balance beam; various balls; skipping ropes; material strips; balance boards; funnels; step-n-catch; and empty milk bottles. Grade R classrooms all had a storeroom in which they stored the equipment.

The Grade R Programme (2006) was initially implemented weekly as it was being designed and developed on request from the school. The researcher had weekly meetings with the three teachers during the first ten weeks of the Grade R Programme and quarterly meetings thereafter. The meetings were used to train and support the teachers and get feedback regarding activity choices. At the end of the year, the three teachers completed a Grade R Programme questionnaire (Annexure B) to provide feedback on the assessment of developmental milestones, the structure of the programme, the warm-up, stimulation and cool down activities, equipment used, and how they personally perceived the programme over the 40 weeks of implementation in 2006.

The Grade R Programme was thus a pilot draft which was informally tested for feasibility through implementation as the programme was being developed. The feedback from the meetings with the teachers, their recommendations and the feedback from the Grade R Programme questionnaire were implemented as design criteria for the further development of the programme. The teachers continued implementing the Grade R Programme during 2007 while revisions and further development was taking place on the second version of the programme. The second draft was named SEMOSTI Programme to prevent the teachers from confusing it with the first draft.

The SEMOSTI Programme differs notably from the pilot Grade R Programme. It was constructed on weekly basis based mainly on clinical experience. The SEMOSTI Programme, on the other hand, is based on theories regarding motor development and physical activity in children. The theories and principles underlying the SEMOSTI Programme will be discussed in more detail under programme theory (section 2.5.2).

In terms of manuals, the Grade R Programme was given to teachers as loose printed pages which they filed while the SEMOSTI Programme are printed and ring-bound as a user-friendly manual, including a cover page with a clear title. Week 1 through to Week 40 are tagged for easy location. The assessment of developmental milestones section is expanded with written descriptions for each section on the form.

The structure of the two programmes differs in that the Grade R Programme's activities were repeated every 10 weeks (thus, weeks 11 to 20 were a duplicate of weeks 1 to 10). The SEMOSTI Programme repeats activities every fourth week (thus a selection of activities from weeks 1 to 3 are repeated in week 4 while weeks 5 to 7 consist of novel activities), which is an advantage because the repetition of activities are decreased to encourage continued participation. The Grade R Programme scheduled three assessments of developmental milestones across the year (January, June and November) which was decreased to two in the SEMOSTI Programme (Week 16 and Week 32).

In terms of content, the form for the assessment of developmental milestones was adapted in the SEMOSTI Programme to include more sensory aspects such as awareness of movement, touch and auditory processing. The warm-up and cool down activities of the Grade R Programme were changed to alert and calming activities based on self-regulation principles (9,157). The stimulation activities of the Grade R Programme are better graded across the SEMOSTI Programme.

Programme outcomes

The SEMOSTI Programme was designed to achieve the following outcomes:

- To improve the motor skills of four-to-six-year-old children through structured, age-appropriate sensory-motor experiences and opportunities to practice foundation motor skills.
- To increase the physical activity of four-to-six-year-old children and to expose them to the enjoyment of physical activity through offering a wide range of age-appropriate and fun activities for 45-minutes daily.
- To inform and guide teachers in early identification of children with definite sensory-motor delays through comparing children's abilities with typical developmental milestones.

The intended outcomes of the SEMOSTI Programme were ascertained firstly by selecting theories on sensory-motor development from which principles were drawn to guide the design of the programme content. Secondly, physical activity guidelines were incorporated into the content. Thirdly, the role of teachers was taken into account. These will next be discussed and application thereof in the SEMOSTI Programme will follow in 2.5.2.

Theories on Sensory-Motor Development

The following theories are fundamental to sensory-motor development in children and were used as the foundation for the SEMOSTI Programme.

- *Neuro-Maturation Theories*

Historically, the Neuro-Maturation Theories (NMT) suggested that motor development was primarily dependent on the maturation of the nervous system (158, 159). The profounder of these theories thought that motor development takes place with the control of the lower reflexes by the cortex increasing over time and that this development follows predetermined patterns (160). Thus, according to the NMT, typical motor development was formed on a strict genetic developmental scheme as its foundation (160). This would suggest that a child's experience and intervention, such as the SEMOSTI Programme or therapy, could only have a limited impact on motor development. However, in 1943 McGraw (161) started exploring motor development as a product of both nature and nurture, which guided future research and is still accepted today.

The focus of motor skill intervention should be the enhancement of the natural sequence of motor development (162). This approach links with NMT, which suggest that motor development follows predetermined patterns (160). Children should acquire the fundamental motor skills, as research has proven that if they fail to learn the foundation motor skills they tend to have decreased participation in games and sport and experience failure in general motor tasks (141,162). One recent study conducted in Australia demonstrated that the mastering of fundamental motor skills was low among primary school children, highlighting the importance of early intervention programmes in preschools and childcare centres (141) to enhance motor development.

- *Dynamic Systems Theory*

The Dynamic Systems Theory (DST) (also called systems theory) proposes a flexible model of neural organisation in which the functions of control and coordination are distributed among many interdependent elements of the system, such as specific environmental conditions, the infant's mood, central nervous system, joint configuration, muscle strength and body weight (163,164). In DST, movement patterns emerge through generic processes of self-organisation found in physical and biological systems (165). Thus, systems outside the child can influence motor performance and skills acquisition (31). Motor skills are acquired through active practice and experimentation with varied tasks. Changes to the environmental conditions, task requirements or multiple component parts (i.e. muscle strength, postural support, etc.) will result in a specific type of motor behaviour (166). In contrast to NMT which is a hierarchical model, DST suggested a flexible model where motor behaviour is due to the interaction of multiple subsystems with influences from the general context, environment and particular tasks (167). The main difference between NMT and DST is the role of the nervous system (165).

- *Neuronal Group Selection Theory*

Neuronal Group Selection Theory (NGST) found a midway point between the NMT and DST (168) stating that motor development is the result of a complex interaction between the environment and genes. According to this theory, there is variation in normal motor development which is determined by genetic information (166,168). NGST suggests that there is first a primary variability phase (not geared to external conditions) and then a secondary variability phase (motor performance can be adapted to specific situations) in motor development. Sensory information received from the environment plays an important role during both phases of variability by facilitating selection. The process of selection reduces the extent of motor possibilities resulting in an ability to adapt each movement exactly to task-specific conditions or generate various strategies for a single motor task. Therefore, NGST argues that sensory information has an important function in motor development (168).

The NGST promotes various sensory-motor experiences as intervention for children with motor dysfunction, with a later intervention shift to opportunities for active practice (166). Active practice reduces variability by facilitating the selection of the most effective motor strategy. Thus, NGST argues that active sensory-motor experiences improve motor function through enhanced selection (166).

- *Sensory Integration Theory*

Sensory Integration Theory, pioneered by Ayers, is an approach based on neuro-maturation theory and dynamic systems theory (169). Firstly, the theory states that sensation is registered and processed from movement and the environment which is used to organise and plan behaviour resulting in learning (169). Secondly, individuals who have a decreased ability to process sensation also may have difficulty producing appropriate actions, which, in turn, may interfere with learning and behaviour (169). And lastly, enhanced sensation, as a part of meaningful activity that yields an adaptive interaction, improves the ability to process sensation, thereby enhancing learning and behaviour (169).

Initial studies in the 1970s (170-172) reported increased motor, academic and language performance as a result of sensory integration therapy (SIT) as originally developed by Ayers. Due to more rigorous research methods in later years, subsequent efficacy studies regarding therapy based on a sensory integration approach, did not report significant positive effects or demonstrated effects equal to alternative treatments (173,174). However, it was later found that many publications and intervention programmes were mistakenly associated with sensory integration but they did not truly reflect the core principles of Ayers' work (175). Consequently, the Baker/Ayers Trust trademarked the term Ayers Sensory Integration® to clarify concepts related to Ayers' sensory integration framework and preserve the integrity of the work (176,177). Ten core elements were also defined as fidelity criteria for Ayers Sensory Integration ® therapy (ASI) (176,177).

Other concepts and forms of intervention, such as sensory diets and self-regulation strategies, have since been developed which is based on Sensory Integration Theory but differ from classical SIT and ASI (10, 20,169). Self-regulation is an outcome of adequate sensory integration (31). According to Williams and Shellenberger (20), self-regulation is the ability to change or maintain levels of alertness by using appropriate sensory strategies. When difficulties in self-regulation occur (e.g. a child being hyperactive when he is required to sit quietly and do handwriting), individuals have trouble changing their levels of alertness, which in turn compromises their ability to function and learn (20). Children who tend to function at a high level of alertness (on-the-go) or who tend to function at a low level of alertness (zoomed-out) might experience difficulties to learn new sensory-motor skills (20). This may indicate sensory processing problems and the child should be referred for professional help.

Sensory strategies are suggested to change levels of alertness at home and in the classroom to enable the child to be in the optimal level of alertness for optimal learning (178). Research findings demonstrated that specific sensory experiences influence the function, structure, and neurochemistry of the brain (179,180). Repeated or sustained sensory-motor input has been proven to result in lasting neurological changes (181). Williams and Shellenberger (20) developed the Engine Programme® which suggests five types of strategies (namely move, look, listen, touch and put something in your mouth) to help the child be calm, organised and alert (178). Variations in these strategies results in either a calming or activating effect on the child (178). In general, fast, novel and irregular movement are activating whereas slow, repetitive and rhythmic movement are calming (178). For look, bright environments with sharp contrast are activating whereas soft lighting and bland and monotonous sights are calming (178). Loud and variable sounds are activating whereas soft and rhythmic sounds are calming (178). Light and brisk touch are activating whereas firm and sustained touch are calming (178). Lastly, blowing/sucking and distinct tastes, such as sour and spicy, are activating whereas sucking/blowing and bland tastes, such as hot tea are calming (178). However, some children might experience some calming activities as alerting or vice versa depending on their individual sensory systems (20).

- *Motor Control Theory*

Motor control theory explores the ways in which the interaction of the child with the task and environment produces movement (10). When learning a new functional task, a child acquires movement synergies or coordinative structures, which is refined and organised through continued practice (10). Reflex theory, hierarchical theory, complex systems theory and task-based approaches falls within theories of motor control (10).

Motor learning is an approach, based on motor control theory, with the focus on the acquisition of skills involved in movement and balance (10). Evidence indicates that motor learning is improved when the child is involved in a purposeful, functional activity rather than being passively moved or performing a repetitive, nonpurposeful activity (10). A study by Apache (182) compared the effectiveness of an activity-based intervention programme to the effectiveness of a direct instruction programme, for preschool children with developmental delays or who were at risk for delays. The activity-based intervention method resulted in with significant improvement in the development of gross motor skills compared with the direct instruction method (182).

Dadkhah stated that the preschool child develops mostly through play activities (183). This suggests that play-development rather than training-development should be the focus of intervention during the preschool years (183). Play is characterised by positive affect, active engagement, intrinsic motivation, and freedom from external rules, attention to process rather than product and lastly, nonliterality (184). According to Dadkhah, aspects such as enjoyment, concentration and positive motivation are encouraged through play (183). She suggests that the positive effect generated during play impacts on the limbic system, which, together with the motor control system, generates adequate motor performance (183).

Children learn more when motivated, which occurs in two orientations: mastery or performance (10). Ames describes mastery orientation as a desire to master a skill or topic and become proficient (185). By comparison, performance orientation (185) is described as a desire to perform well and achieve high marks or scores, such as grades. Mastery orientation is associated with greater engagement and perseverance, while performance orientation is associated with higher levels of anxiety (185). Research by Martin, Rudisill and Hastie (186) found that children's motor performance was positively influenced by a mastery motivational climate. A self-directed climate even benefited young children compared with a low autonomy climate physical education intervention (186, 187). Thus, children learn motor skills more effectively if they have an interest in doing so.

Evidence does not support the suggestion that any one of these theories is the only correct one. However, on the basis of these theories, one could argue that motor development depends on the physical maturation of the nervous system and body systems of the child and increases through experience and selective active practice (2), which formed the foundation of the SEMOSTI Programme. The programme outcomes, session-by-session content, selection of activities and programme structure were based on principles, which were drawn from these theories (section 5.2.2).

Increase Physical Activity in Children

One mayor aspect, which has come to the fore in literature, and has influenced the development of the SEMOSTI Programme, was the need to increase physical activity in children. The promotion of physical activity has become an important focus worldwide (188). The Centres for Disease Prevention and Control (CDC) and various other studies have researched the promotion of active lifestyles among children and outlined the following developmentally appropriate guidelines for activity of preschool children (78,188-191):

- On a daily basis, children should accumulate at least 60 minutes of age-appropriate physical activity (78,188-191).
- The daily 60 minutes of physical activity should not be continuous, but rather spread over several bouts lasting 15 minutes or more (78,188,189).
- Children should participate in different types and intensities of age-appropriate physical activities (78,188-191).
- Children should be discouraged of spending long periods (two or more hours) inactive or sedentary especially during the day (78,188-191).

Physical activity and motor development in children are interdependent. According to Bates, children's patterns of activity differ greatly from those of adults (78). Children naturally develop fundamental motor skills through being physically active which in turn, promotes further physical activity (78). A solid motor skills foundation will affect the preferred leisure-time activities throughout one's life (78). Therefore, by providing sensory-motor experiences through which children can develop and practice fundamental motor skills, physical activity is increased.

Corbin and Pangrazi (188) recommended the Physical Activity Pyramid as a model for physical activity requirements specific to young children. The model describes five different types of activities through which physical activity is accumulated, including moderate and vigorous activity, muscle fitness and flexibility activities for children (188). The general suggestion for the four-to-six-year-old child is to accumulate 60 or more minutes a day from lifestyle activities such as playing outside, doing chores around the house, playing games or walking with parents, with some vigorous activity involving running, jumping, cycling or recreational sports. However, the younger child will be less likely to participate in recreational sports compared to the older child (188).

The physical activity throughout one's lifespan is influenced by one's environment (192-194). Therefore, preschools provide an important opportunity to target the physical activity of children at a formative age (194). Salmon (195) stated that the most effective physical activity interventions among children aged four to twelve appear to be in the school setting and include physical education, activity breaks and family strategies.

Two independent studies conducted respectively by Tell and Vellar (196), and McKenzi, Nader, Strikmiller, Yang, Stone and Perry (197) focused both on physical activity interventions implemented at schools. Data from both studies indicated increases in physical activity in children through school-based interventions; however, the improvements appear to be short-term (196,197). Bates commented on these findings (78) suggesting that the short-term nature of the improvements did not indicate that school-based programmes are ineffective, but rather questioned the validity and reliability of these research findings.

Role of Teachers

The Grade R teachers implemented the SEMOSTI Programme in the classroom setting. Riethmuller, Jones and Okely (198) reviewed the effectiveness of motor development interventions in young children and recommended that teachers implement interventions. They also highlighted the role of parents whose involvement was necessary for transfer of knowledge and skills to the home environment (198). This view supported Sugden (199,200), who stated that non-specialists such as teachers and parents played an important role in providing effective intervention for children with motor impairment, for all but the most severely affected children, due to limited professional resources. Parents do not play a role in the SEMOSTI Programme but this should be considered for further development.

Research by Pless, Carlsson, Sundelin and Persson (201) has shown that group motor skills intervention, such as that in a classroom setting, is effective for children with borderline motor difficulties. This study demonstrated that significantly more children with borderline motor difficulties than children with more severe problems improved their motor proficiency after weekly group intervention over a period of ten weeks (201). This indicates that teachers could play an important role in presenting intervention in a classroom setting for children with borderline motor difficulties. The same study found that children who presented with definite motor difficulties did not benefit from group motor skills intervention (201). This suggests that children presenting with definite motor difficulties should be identified early in order to receive effective therapeutic intervention.

Research by Piek and Edwards (202) suggests that teachers might be effective in early identification of children with severe motor difficulties. Specially, they studied the ability of physical education and class teachers to identify children with coordination problems using the Movement Assessment Battery for Children (MABC) checklist (202). The sample's coordination was tested and the results were compared with the results of the MABC checklist completed by physical education and class teachers. The results showed that physical education teachers identified 49% of children with severe motor difficulties while class teachers were only able to identify 25% (202). This indicates that physical education teachers, and class teachers to a lesser degree, might prove effective in early identification of children with severe motor difficulties.

2.5.3 Application of Step 2 – Specify Programme Structures and Processes

2.5.3.1 SEMOSTI Programme theory and principles

In this section, the underlying theory and application thereof in the implementation of principles of the SEMOSTI Programme will be discussed. The discussion will follow the structure of the programme (Alert, Just-Right challenges and Calming Sections as well as Evaluation of developmental milestone section) and will refer to theories on sensory-motor development, strategies to increase physical activity and the role of the teacher in the implementation of the intervention. Figure 2-2 relates the theories and principles to the SEMOSTI Programme.

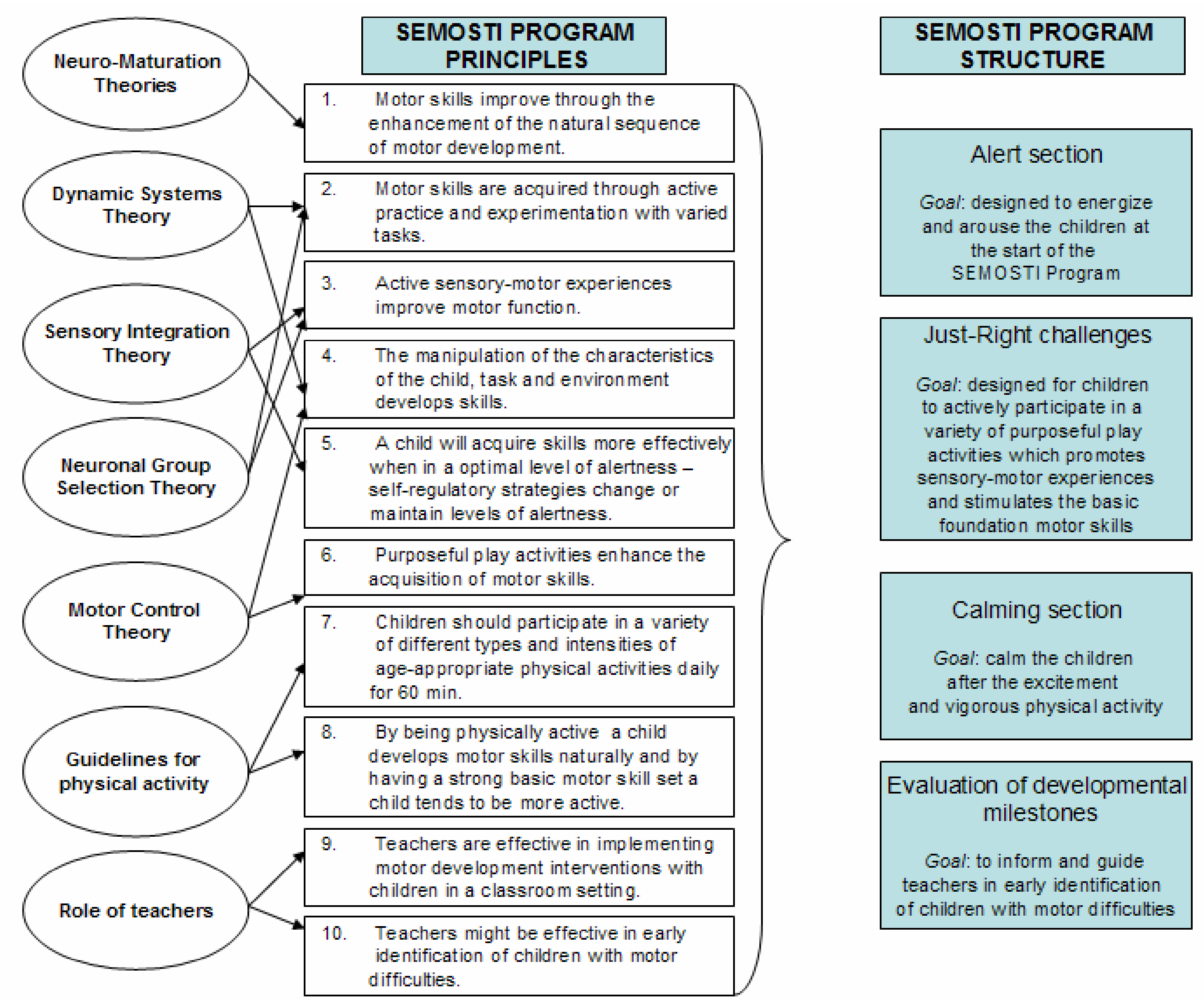

Figure 2-2 SEMOSTI Programme Theory And Principles

The Application of Theory in the Alert Section

The Alert section of the programme is based on foundation principles for self-regulation (20) as children require a certain quality and quantity of sensory experiences to be skilful, adaptive and organised in their daily lives (157). Games were chosen to energise and arouse the children and of the five types of self-regulation strategies, movement and auditory were primarily applied and tactile strategies were applied to a lesser degree. The visual and oral strategies were not included as it is difficult to implement within a group setting. Specific treatment techniques were not prescribed rather active bodily movements were suggested which children participated in, as they felt comfortable.

Movement strategies included novel activities that catch children's attention, irregular and rotary movements, erratic bouncing, hard work activities and fast movement (9,178). These activities required active bodily movements and did not made use of specialised sensory integration based equipment. Movement can be stopped at any time, as the child is actively moving and thus in control of the movement. Examples of such games are spinning in one direction and then in the other direction, swimming breaststroke in the prone position on the floor, doing somersaults, performing continuous jumping jacks, and rolling downhill.

Auditory strategies were applied by instructing teachers to speak loudly and fast, to use exciting music as background music and to execute the tasks at a fast tempo (9,178). These elements ensured that the games are excitatory in nature.

Tactile strategies were applied by using light tactile input (9,178). Examples of such games are splashing one's face with cold water; and tickling.

In addition to applying principles of self-regulation (20) , the games of the Alert section address the first level of the sequence of motor development, namely the sensory systems (9). The tactile, vestibular and proprioceptive systems are mostly stimulated through active participation. Through active participation in fun games, the process of registering and processing sensory input from the environment and the child's body is enhanced. These enhanced sensory-motor experiences are given as preparation to promote specific skills in the Just-Right Challenges (203). These sensory-motor activities were based on Sensory Integration Theory but does not qualify as SIT and ASI (10,20,169). Examples of such games are rubbing body off with a towel, jumping into a soft surface, and lying on a piece of cardboard, piece of carpet or scooter board while moving (full body tactile input), spinning, running, rolling (vestibular input), crawling on all fours, pulling a friend on a piece of carpet, and pushing a friend on a scooter board across a smooth surface (proprioceptive input).

The Application of Theory in the Just-Right Challenges

The Just-Right Challenges are designed to stimulate sensory-motor skills in four-to-six-year-old children. The focus of the programme is not on the mastering of a single skill, such as ball skills or balance skills, but consists of specially selected and graded activities, which address the whole sensory-motor spectrum of development (sensory processing, perceptual processing, neuromusculoskeletal aspects and motor skills) in the four-to-six-year-old child. This is to ensure that the child develops a strong sensory-motor foundation on which perceptual-motor and cognitive skills can be built.

During the design of the SEMOSTI Programme, the researcher aimed to spread activities equally across the 40 weeks. For instance, on a weekly basis one tactile, auditory and motor planning activity were included instead of ten motor planning activities. Each Just-Right challenge was analysed to determine the performance components required to perform the activity competently and listed on a primary sensory and motor components table. Performance components are listed as follows: auditory processing, body awareness, integration of the two sides of the body, motor planning, eye movements, awareness of touch, awareness of movement and visual-spatial perception. Activities were analysed based on sensory integration, NMT and motor learning theory (31). Only the three main components per activity were indicated to simplify it for the teachers. Many performance components were not listed such as processing of proprioception, left-and-right-discrimination, or postural control in order to keep the manual simple and user-friendly.

The SEMOSTI Programme uses activities to master age-appropriate skills, based on motor control theory, rather than exercises (182). Exercise is defined as physical activity that is planned, structured, and repetitive for conditioning any part of the body, while activity is defined as a state of doing or energetic action (17). Children learn more effectively through participation in activity (182). Play-development rather than training-development is the focus of intervention (183) and as such, play is an essential element of the SEMOSTI Programme. Positive affect was incorporated into activities by creating an environment within which the children might experience pleasure and fun while executing daily activities, which have an end-goal ranging from hitting a target; completing an obstacle course; completing the steps of an activity or beating a rival team in a game (184).

The Just-Right Challenges were selected and designed to stimulate the areas of sensory-motor development and foundation skills age-appropriate for four-to-six-year-old children. According to NMT, motor development follows predetermined patterns, and developmental milestones are based on these predetermined patterns of development (160). Preschool children's gross motor/mobility skills change significantly during early childhood (10). From the age of four children start jumping down from high places, jumping forward, throwing balls, throwing balls at a target, hopping a sequence, climbing playground equipment, skipping and walking up and down steps reciprocally (10). By the age of six they can hop well, skip with good balance, catch a ball with two hands, kick with accuracy and stand on one foot for 8 to 10 seconds (10). Games were thus selected and designed for the SEMOSTI Programme to target these developmentally appropriate motor skills such as, “albasterbal” (rolling tennis balls at a target), “paddasponge” (jumping over the squatted back of a peer), and “balansbal” (throwing and catching a ball while sitting on a balance board).

According to DST, motor development can be influenced through the interaction of physical and biological systems, with the environment (165). For this reason, sensory-motor skills are enhanced through the Just-Right Challenges by making use of the following factors: the use of a variety of games (movement games, ball games, jumping games, balancing games, obstacle courses etc.), the use a variety of equipment (tennis balls, soccer balls, beanbags, ropes etc.), within a variety of environments (indoors, outdoors, downhill etc.), and executed individually or in groups.

Just-Right Challenges were carefully graded across the 40 weeks. Games were graded in terms of complexity (from simple to more complex movements) and effort required (easy to more effort). In doing so, the environment was modified to enhance motor skills as suggested by DST (165). For example, Week 1 starts with simple games such as Simon Says (one-step simple instructions) and “Vliegtuigie” (sustained prone extension position), which is graded into more complex games such as “Donker Doolhof” (three-to-four-steps complex instructions) and “Spierkrag Hindernisbaan” (an obstacle course including “Vliegtuigie” with various other sustained postural controlled positions).

Sensory-motor development depends on the integration of sensation and movement (10). The body continuously receives sensations such as vision, hearing, smell, taste, touch, movement and proprioception from the body and the environment. The sensations received from the sensory systems are organised, processed and integrated in the brain to plan and execute a motor response appropriate to the situational demands to enable successful execution of daily tasks (10). According to NGST, the best motor solution for specific situations is selected through various motor experiences, resulting in optimal adaptation of motor outputs necessary for motor proficiency (166,168). Therefore, the Just-Right Challenges stimulate the basic foundation sensory-motor skills through creating opportunities for enhanced selection and active practice. This is accomplished through daily scheduled activities which provides various motor experiences in which children actively participate

The children were actively engaged in the SEMOSTI activities by presenting age-appropriate tasks. The teacher would adapt the level of activity to be a just-right challenge by applying the adaptation suggestions. If the activity was too difficult, the child would experience failure and avoid the task and if the activity was too easy, the child would be bored quickly. In neither case would the child adapt and improve upon his skills, and therefore, the teacher would make changes to the tasks to accommodate the child's needs. This is accomplished through adaptation suggestions such as moving the target closer or further, executing balancing tasks with eyes open or closed, or changing the size of the ball used in the activity (e.g. soccer ball or tennis ball).

Intrinsic motivation was facilitated by presenting new activities daily (a selection of activities was repeated every fourth week), adapting elements in an activity to give a new angle to a familiar experience and achieving mastery of known objects, such as a jumping rope. In some activities the children were extrinsically motivated by competition with other children. The focus was kept on the process or performance of the activity rather than on a goal or the end results.

A mastery orientation climate was incorporated in the Just-Right Challenges by utilizing the above-mentioned play characteristics, particularly intrinsic motivation. Children were not expected to master motor tasks through repetition, for instance doing fifty star jumps daily or running three laps weekly, or given external indicators of success such as medals. Rather they were presented with play activities using a variety of equipment with the focus on the execution rather than the result within a relaxed and fun atmosphere. This approach was preferable as research has proven that children learn more effectively within a mastery orientation climate (186,187).

Through active participation in the SEMOSTI Programme children were physically active, and thereby potentially improving their motor skills, as research have proven that fundamental motor skills develop naturally through physical activity (88,89). The SEMOSTI Programme provided 45 minutes of daily moderate to vigorous physical activity. Children were active in several bouts between the Alert, Just-Right Challenges and Calming activities. The SEMOSTI Programme consisted of age-appropriate activities such as running, jumping or tumbling, that fell under the lifestyle activities as categorised by Corbin in the Physical Activity Pyramid (188).

Application of Theory in the Calming Section

The Calming section is based on foundation principles for self-regulation (20). The games were chosen to calm and organise the children. Of the five types of self-regulation strategies (178), movement, auditory, oral and tactile were primarily applied to the calming activities. The visual strategies were not included as it is difficult to implement within a school setting.

Movement strategies were applied by using slow, rhythmic and linear movement in games, deep pressure to the palms or trunk, slow muscle stretching and heavy physical work (9, 178). Examples of such games include slow animal movements while acting out a story, slow stretching, crawling against resistance, pushing against a wall, and slow rocking.

Auditory strategies were applied to activities by instructing the teachers to speak with a soft voice and to speak slowly and/or by executing games while using soothing music in the background (9, 178). These elements ensured that games have an inhibitory effect on the children, as soft and rhythmic sounds tend to be calming (178).

Oral strategies were mainly through sustained heavy work of the mouth that included blowing and slow breathing exercises (9, 178). Examples of such games are slow breathing, mouth soccer using straws and cotton balls, blowing bubbles, and blowing out candles.

Tactile strategies included slow, sustained whole body deep pressure and deep pressure through weight bearing (9, 178). Examples of games utilising these strategies are making a hotdog by rolling oneself up in a blanket, and crawling through a stretchy material tunnel.

In addition to applying principles of self-regulation (20), the games of the Calming section address the first level of the sequence of motor development, namely the sensory systems (9). The tactile, vestibular, oral and proprioceptive systems are mostly stimulated through active participation. Examples of such games are rolling against a wall, rocking body over a ball, and crawling under and through blankets (full body tactile input); marching, rocking and rolling (vestibular input); blowing table tennis balls around with straws and blowing balloons (oral input); lastly stretching, crawling and pushing against resistance (proprioceptive input).

Application of Theory in the Evaluation of Developmental Milestones

Developmental milestones for infants and young children are based on predetermined patterns of motor development as suggested by NMT (160). When a child fails to reach certain developmental milestones, it may indicate possible underlying motor problems (204). However, motor development in early childhood is characterised by considerable variation. NGST aims to explain this variation by suggesting that basic programmes for motor development is genetically approximately recorded with a lot of variation as the child learns through trial and error (166,168). Typical milestones for the period, three-and-a-half-years to six-and-a-half-years, were obtained from various sources and include categories such as auditory processing, awareness of touch, awareness of movement, gross motor skills and body awareness (10, 13,204).

Auditory processing, awareness of touch, awareness of movement and relates to sensory processing which are based on sensory integration theory (205). Auditory processing is the perception and ability to comprehend what is heard (205). Some children might be over-responsive or under-responsive to auditory input, affecting their ability to follow instructions and focus on the task at hand (205). Awareness of touch is the sensation received from the skin (205). Some children might be over-responsive or under-responsive to tactile input affecting their ability to focus, their emotional responses, their behavioural responses and manipulation of tools or objects (205). Awareness of movement refers to the processing of movement through the vestibular system (205). Some children might be over-responsive or under-responsive to movement input affecting eye movements, posture, muscle tone and activity level (205). Teachers were expected to only observe the children while presenting various SEMOSTI Programme activities to be able to indicate on a broad scale if the child presented with either sensory-sensitive, typical or sensory-seeking behaviour. In terms of auditory processing, teachers were expected to observe the children to be able to indicate if the child can follow instructions.

The typical motor milestones for gross motor skills in terms of, balance, movement and ball skills were based on NMT (160). These milestones indicate the expected age at which a child should be able to execute a motor task, for example to balance on one foot; jump with two feet together; or catch a ball. Teachers were expected to observe the children to be able to indicate if the child has mastered a specific milestone.

The body awareness section refers to body concept in terms of the name, location and function of each body part (204). Teachers were expected to ask the children to name the body parts and draw a picture of their bodies to indicate if the child has mastered this milestone.

The Evaluation of Developmental Milestones section is included in the SEMOSTI Programme as Piek and Edwards (202) suggested that teachers might be effective in the early identification of children with motor difficulties. Teachers are encouraged to assist the child to master skills if difficulties are experienced in one or two areas of development. However, if a child has trouble in more than two areas of development, teachers are encouraged to refer children for occupational therapy, as Pless et al. (206) found that children with definite motor difficulties do not benefit from group motor skills intervention such as given in a classroom setting.

2.5.3.2 SEMOSTI Programme Manual Structure

The SEMOSTI Programme spans the 40 weeks of a school-going year each week consisting of five days of activities, of which some are repeated every fourth week. Each day’s activities are divided into three sections: Alert, Just-Right Challenges and Calming sections (Annexure C). Weeks 16 and 32 are scheduled to evaluate the children’s development by comparing results with the typical developmental milestones of that age group.

A typical school calendar spans 42 weeks over a 52-week year, interspersed with school holidays and public holidays. The first week and last week of a typical school year are mostly used for orientation and administration, during which teachers typically do not follow a formal class plan. As the specific dates of school and public holidays change from year to year, it was decided to construct the manual as Week 1: Day 1 (Monday) to Day 5 (Friday), Week 2: Day 1 (Monday) to Day 5 (Friday), etc. If a public holiday fell on Week 11: Day 3 (a Wednesday), teachers did not implement Day 3 but continued with Day 4 on the following day (Thursday). If the school ended on Week 12: Day 4 for a two week holiday, the teachers started with Week 13 in the new term starting on the corresponding day of the programme. All teachers implemented the same activities on the same days.

Alert Section (Annexure C)

The Alert section of the manual is designed to energise and arouse the children at the start of the day's SEMOSTI Programme. This section is scheduled for about 10 minutes and each child within the group executes one excitatory activity individually. Approximately 30 activating activities are repeated across the 40 weeks.

This section of the manual provides teachers with a short description explaining in which manner to give the instructions, for instance speaking fast and loud. This is followed by a short description of the excitatory activity. At the end of this section, the children should be alert, be able to pay attention and to participate successfully in the Just-Right challenges.

Just-Right Challenges (Annexure D)

The Just-Right Challenges are designed for children to actively participate in a variety of purposeful play activities that promote sensory-motor experiences and stimulate the basic foundation motor skills. Opportunities are given for practice and experimentation with a variety of objects to acquire motor skills. The SEMOSTI Programme consists of 380 novel and traditional Just-Right Challenges over 40 weeks, of which 80 games are repeated every fourth week cycle. This section is scheduled for about 30 minutes, and includes two games, daily. Each game comes with written instructions on a separate page in categories of equipment, activity, adaptations and observations.

- *Equipment*

The equipment needed for each game is listed in the manual. A wide range of affordable and easily accessible equipment was used throughout the SEMOSTI Programme, such as balloons, soccer balls, tennis balls, beanbags, rope, balance beam, empty boxes, pieces of discarded carpet, tennis bats, hula-hoops, scooter boards, inflatable inner tubes, a ladder and step-n-catch. The researcher provided the school with scooter boards and tactile tunnels as the school owned the rest of the required equipment.

- *Activity*

Each game's instructions are provided in the manual in easy-to-follow steps. The format of the instructions varies according to the specific game. Generally, instructions are given on how to organise the activity, for instance, where to execute the activity, where to place the equipment and how to space the equipment pieces. The organisation of the children is also explained in regards to whether the activity is to be executed by children individually, in groups of four, or by forming two queues. The steps to execute the activity are listed if necessary.

Precautions when conducting an activity are listed for a few activities if the researcher deemed them possibly harmful. That said, participation in all activities involved minimal risk associated with everyday life, such as running, rolling, kicking or throwing.

- *Adaptations*

Suggestions are listed under the category of adaptations that include ways to make the games more difficult or easy, or to change the game by adding different elements. The adaptation suggestions enable the teacher to change the activity so that each child can master the challenge, irrespective of his or her ability.

- *Observations*

The last category in the manual for the game is observations. Questions are listed to guide the teacher in their observations of the children participating in the game. The questions help the teacher to know what to expect from the children, what they should be able to do and how they should do it. The answers to the questions guide the teacher in her/his decision to either adapt the game to be easier, to assist a child to master the game or to identify problem areas in a child.

The Just-Right challenges are tabled for each week according to the primary sensory and motor components addressed by each game and the use of equipment (Annexure E). The function of this table is to guide the teachers regarding the components of development on which each game is focused, which will enable teachers to identify the possible problem areas in children early in order to refer them for professional intervention.

Calming Section (Annexure C)

The SEMOSTI Programme ends each day's session with the Calming section, which aims to relax the children after the excitement and vigorous physical activity of the Just-Right challenges. This step is imperative as the children need to be calm and alert to continue with the educational plan after the SEMOSTI Programme. This section is scheduled for about 5 minutes and each child in the group setting executes one calming activity individually. Approximately 122 calming activities are repeated across the 40 weeks.

In this section of the manual, a short description is given explaining how to give the instructions, for instance speaking soft and slow. This is followed by a short description of the calming activity. At the end of this section, the children should be calm, organised and ready to continue the educational plan for the day.

Evaluation of Developmental Milestones (Annexure F)

Early identification of developmental problems is imperative and teachers can play an important part in the identification process. As previously noted, Weeks 16 and 32 are scheduled to evaluate the children's development by comparing it with the typical developmental milestones for that age group.

The evaluation process is executed in three steps in approximately 15 minutes per child. Firstly, each child's chronological age is calculated. This is done by subtracting the child's date of birth from the current date. A balance of more than 15 days is counted as an extra month. Secondly, the relevant milestone table for the specific age group of each child is selected. The milestone tables are compiled with six months intervals, starting at three years and six months old and ending at six years and six months old. Five areas of development are assessed, such as awareness of movement, awareness of touch, auditory processing, gross motor skills (balance skills, movement skills, ball skills) and body awareness (Annexure F). The assessment of awareness of movement and awareness of touch is based on observations. The assessment of auditory processing is based on the child's ability to follow instructions and use words in sentences. Gross motor skills are assessed through tasks such as balancing on one leg, hopping, galloping and catching a tossed beanbag. Body awareness is assessed by drawing a picture of a man and identifying body parts. Lastly, after each child's developmental milestones have been assessed, a plan of action is selected. If the child has reached all the milestones, no intervention is needed. If the child experiences difficulty in one or two areas, the teacher should assist the child to master the skills by selecting specific activities to be practiced at home. If the child experiences difficulty in more than two areas, the child may have definite sensory-motor delays and should be referred for occupational therapy (200,207).

The categories listed on the milestone table included: awareness of touch, awareness of movement, auditory processing, gross motor skills such as balance, mobility and ball skills, and body awareness. The categories awareness of touch, awareness of movement, auditory processing and body awareness link up with the performance components listed on the weekly primary sensory and motor components table.

2.5.3.3 Review first draft of manual and start pilot testing

According to Fraser and Galinsky (155), experts should review the first draft of the manual once it is created to ensure that the content targets the problem and is appropriate for the population and setting. The first draft (Grade R Programme) of the intervention strategy was designed in collaboration with an occupational therapist with experience in childhood development and was under continuous review. Feedback was concurrently received from the three grade R teachers, who can be seen as stakeholders in the process, during meetings and through questionnaires. The second draft was based on the results of this review and revision. However, scholars in the field did not review the second draft (SEMOSTI Programme) prior to pilot testing, due to time constraints. This is a possible limitation to this study.

Once the review and revision of the manual reach a point where the content is deemed sufficient, the next step is pilot testing (57). Pilot testing is done to determine if the intervention is practical, reasonable, and potentially effective when implemented (57). The current study fits into this phase, as it is a pilot test of the second draft (SEMOSTI Programme). Fraser and Galinsky (57) state that the manual is refined through different studies, testing the different intervention components. This study focused only on the first outcome of the SEMOSTI Programme. The purpose of the SEMOSTI Programme is to stimulate sensory-motor development of four-to-six-year-old children. However, age-appropriate, well-coordinated motor functions, such as skipping, throwing a ball at a target or balancing on one foot, are only possible if information received through the sensory systems are effectively integrated in the cortex on a sensory-motor developmental level and relayed to the appropriate muscle synergies to execute smooth and accurate motor actions (10,205). Therefore, the impact of the SEMOSTI Programme on motor skills in relation to motor proficiency was investigated.

This study investigated the second draft (SEMOSTI Programme) in it's current state. No adjustments, revisions or changes were made to the programme during the study.

As discussed in section 2.2, possible confounding variables were selected which could adversely affect the outcome of the study of the SEMOSTI Programme and gross motor proficiency, which is briefly mentioned here again for readability. The variables, physical activity (12); BMI (139); perinatal morbidity (140) and gender (2) were taken into account to ensure valid and reliable results, while, the study's exclusion criteria addressed the effect of certain disorders/diseases on the results.

2.6 SELECTION OF FIVE GROSS MOTOR SKILLS

The current study is interested in the development of gross motor skills in relation to motor proficiency in four-to-six-year-old children. Therefore, five gross motor skills were selected as the focus of this study, namely locomotion (running speed and agility), balance skills, ball skills (upper-limb coordination), bilateral coordination, and strength. The selection of the five gross motor skills was based on three factors, namely relevance to the SEMOSTI Programme, measurability and age-appropriateness.

Firstly, five gross motor skills which matched the prominent sensory-motor skills addressed by the SEMOSTI Programme were selected. As discussed in section 2.5, the Just-Right Challenges address the whole sensory-motor spectrum of development (auditory processing; body awareness; integration of the two sides of the body; motor planning; eye movements; awareness of touch; awareness of movement; and visual-spatial perception). However, this study was limited to only the gross motor aspects due to time constraints. A few activity choices are listed below to demonstrate how the content of the SEMOSTI Programme enhanced the five gross motor skills.

Strength develops through activities requiring resistance (10), such as the games such as "Opstote & Opsitte" (sit-ups and push-ups in obstacle courses), "Muskiete" (sustained supine flexion), "Kniee Sokker" (playing soccer while kneeling) and "Kruiwa Loop" (wheelbarrow walking). Through improved strength basic skills such as jumping, running and climbing are developed (10).

Bilateral coordination develops through activities that require the use of both sides of the body together, either as simultaneous or alternating movement (10). Examples of these games include Jack-in-the-Box (simultaneous movement of upper limbs), Hopscotch (simultaneous movement of lower limbs), "Volg Die Trein" (asymmetrical movement of opposite lower limbs) and "Spring Tou" (simultaneous movement of upper and lower limbs). Through improved bilateral coordination basic skills involved in playing sports and many recreational games such as galloping, skipping, jumping, marching and climbing across monkey bars are developed (10).

Upper-limb coordination develops through activities designed to improved eye-hand coordination and improved shoulder girdle stability, such as "Drombal" (throwing a ball at a target), "Ringe" (throwing rings around a pole), "Gaaitjie Bal" (hitting a ball) and "Klap Bal" (bouncing a ball to another person) (10). Ball skills in terms of throwing a ball, catching a ball and throwing at a target develop through improved upper-limb coordination (10).

Running speed and agility develop through improved body coordination, quickness and speed (10). This skill is enhanced through the exposure to a variety of movement patterns, such as "Rotvanger" (running after peers trying to catch their tails), "Kreatiewe Bewegings" (creative movements such as moving like a whisk), "Lint Dans" (moving ribbons to music), and "Wegkruipertjie" (hind-and-seek). Increased running speed and agility improves the mobility needed to climb steps, participate in sport and navigate spaces (10).

Balance develops through the strengthening of opposing groups of muscles to sustain postures and stimulating the ability to maintain body alignment (10). Balance requires proximal stability and execution of tasks in a controlled manner (10). Skills are stimulated though games such as "Lyf Hindernis" (an obstacle course created by the children's bodies), "Vinkel & Koljander" (jumping between four coloured circles on command), "Aantrek Aflos" (running game with putting on and taking off a piece of clothing) and "Balans resies" (walking heel-toe, walking on stilts and balancing on a balance board). Improved balance, in turn, improves locomotion (i.e. children's ability to move) (10).

Secondly, the five gross motor skills were measurable with a standardised test to provide valid and reliable results. The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (30) measures gross motor skills in children aged four to twenty-one and will be reviewed in section 2.7.

Lastly, the five gross motor skills were related to age-appropriate sensory-motor development occurring in four-to-six-year-old children. During the preschool period the child has to master a range of developmental tasks including locomotion, mastering various gross motor and fine motor skills, developing gender-role identity, defining self-concept, attaining emotional control, expanding language and communication skills, developing socialisation skills, and achieving school readiness (208-211). Success in the later stages of child development depends to a large extent on how successfully the child has mastered the developmental tasks of early childhood (1). The development of the five gross motor skills will be discussed in more depth.

Motor control makes significant advances during the preschool period, which makes it an ideal time to stimulate and practice running speed and agility (1). When toddlers begin to walk, between the ages of eight and nine months, their steps are initially awkward (1). However, walking progresses into a skilled activity by the end of toddlerhood as the stride lengthens speed increases, balance stabilises, and the children can walk for longer periods (1). According to Louw, four-year-old children's walking is basically similar to an adult's and they start changing directions when running (1). From the age of five children are also developing speed and agility; they can run faster than before and respond quickly to obstacles as they run (1).

The preschool period is an ideal time to enhance balance because the control of balance progresses throughout childhood and with the onset of voluntary sitting and crawling, children begin to learn anticipatory postural strategies to coordinate posture and locomotion (212). One study indicated that when four-to-six-year-old children's stance gets disturbed, they display greater and more variable postural responses than younger children (213). Shurmway-Cook suggested (67) that the difference may result from a possible period of transition, when children start to rely more on somatosensory information rather than visual information for postural control and balance. Only at the age of ten to fifteen years do children demonstrate mature postural responses and control of movement as one would find in an adult (213). More recently Harris (214, 214) suggested that children's balance and postural control skills mature to adult levels by seven to eight years of age.

Bilateral coordination develops during early childhood and improves considerably during this time (1). In the development of bilateral coordination existing movements are integrated into smooth and continuous patterns, such as walking, running and jumping (1). New movements are also acquired (1), for instance, in throwing a ball skilfully. By the time the child is in preschool the coordination of the large muscles is mostly in place and it becomes an important time for the coordination of small or fine muscles in manipulation skills, such as writing and drawing, which prepares the children to deal successfully with the challenges of primary school (2).

Scientific literature indicates that, in conjunction with improved postural control and bilateral coordination, upper-limb coordination improves drastically between the ages of four-to-six in terms of accuracy and aim due to maturation and practice (1, 2). Upper-limb coordination functionally translates into ball skills but includes any tasks requiring coordinated arm and hand movement with visual tracking such as placing a coin into a slot (10). Developmentally, ball skills start from as early as the age of eleven months, around the same time as walking independently (204). At the age of four years, children can aim, throw and catch a ball with both hands (204). By the age of five, they can catch a ball thrown from one metre away and their accuracy in catching and throwing the ball starts to improve from the age of six (204).

Strength develops notably during the preschool phase as postural control, motor control and running speed and agility improves (1). Ramsay (215) reported that children develop strength through growth, maturation and practice through neuromuscular development. Muscle growth is promoted through daily activities such as running, jumping, lifting, carrying and handling objects (1).

2.7 MEASUREMENT INSTRUMENTS

This research study investigated the impact of the SEMOSTI Programme on the gross motor proficiency of four-to-six-year-old children in order to conclude whether the SEMOSTI Programme is an effective strategy. The measurement instruments used in this study were as follows and will now be discussed.

- Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)
- Scale and measuring tape
- Questionnaires

2.7.1 Bruininks-Oseretsky Test of Motor Proficiency, Second Edition

The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), is an individually administered measure of fine and gross motor skills of children and youth, from four to twenty-one years of age (30). The BOT-2 is intended for use by practitioners and researchers as a discriminative and evaluative measure to characterise motor performance (30,216). The BOT-2 is a revised version of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) (30). An individual's performance on the BOT-2 can be described by comparing his/her scores to the scores obtained by the normative group (30). The normative group is usually a representative sample of individuals of the same age and the same sex as the participants (30). In this study, the norm group for the BOT-2 is a representative sample of individuals from across the United States (30) due to the unavailability of South African norms, which is a possible limitation. However, this study investigated the impact of the SEMOSTI programme on the gross motor proficiency of the experimental group compared to the control group, who did not receive the intervention. Thus, the standardised scores were adequate to compare the two groups with each other, however results cannot be described in relation to the South African population of the same age and gender.

The choice of a standardised measuring instrument was made based on Wiart and Darrah's comparison of four frequently-used tests of motor proficiency (217,218). The four tests compared were the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), the Movement Assessment Battery for Children (MABC), the Peabody Developmental Motor Scales (PDMS) and the Test of Gross Motor Development (TGMD) (217). The comparison of these four tests (217) is tabled in Annexure G. Wiart and Darrah (217) concluded that any of the four standardised tests could be used, depending on the specific purpose of the particular assessment. Further studies supported the use of the BOTMP to investigate unexplored aspects of motor development (218,219).

Barnhart, Davenport, Epps and Nordquist (40) indicated that, while both the BOTMP and the MABC were frequently used to identify children with DCD, the two tests presented with a lack of agreement in identifying the children (40). That said, it was not the purpose of this research project to distinguish between children with DCD and children without DCD, but rather to measure the improvement children made in gross motor proficiency. Therefore, the BOTMP was still ideal for this study.

The focus of this research project was to determine whether there was an improvement in the children's gross motor skills which can be attributed to the SEMOSTI Programme. Due to time and manpower constraints, only certain subtests of the BOT-2 were administered. The structure of BOT-2 enables the selection of only those subtests relevant to the examinee's individual need (30). In light of this fact, and that the focus of the study was on gross motor skills, only the following motor skills subtests were selected: bilateral coordination, balance, running speed and agility, upper-limb coordination and strength.

- The bilateral coordination subtest was comprised of seven tasks including tapping the foot and finger and jumping jacks (30).
- The balance subtest was made up of nine items ranging from walking forward on a line to standing on one leg on a balance beam (30).
- The running speed and agility subtest consisted of five items varying from a shuttle run to one-legged side hop (30).
- The upper-limb coordination subtest consisted of seven tasks including throwing a ball at a target, dribbling a tennis ball and catching a tossed ball (30).
- The strength subtest consisted of five items ranging from standing long jump, knee push-ups to sit-ups (30).

2.7.1.1 Reliability of BOT-2

Reliability is the extent to which you can rely on the results obtained from an instrument (220). It refers to the ability to produce and maintain consistent results on different occasions where there is no evidence of change (221). The internal consistency, test-retest reliability and inter-rater reliability of the BOT-2 is discussed below.

Internal consistency involves tests for homogeneity and includes the split-half test in which part of a measurement scale measuring one entity is split, usually into odd numbered and even numbered responses, and compared for consistency of responses (41). The internal consistency reliability of the BOT-2 for the subtests was high, with the mean subtest reliability in three age groups (four through seven, eight through eleven and twelve through twenty-one) ranging from high 0.70s to the low 0.80s (30). This reliability was computed for the BOT-2 norm sample using the split-half method, Pearson correlation and adjusted by the Spearman-Brown Formula (30).

Test-retest reliability is the extent to which one rater obtains consistency in a repeated measurement (41). The test-retest study of the BOT-2 was administered twice to 134 examinees (30). The test-retest reliability subtests (30) for the study group, age four to seven, were all sufficient and were as follows: upper-limb coordination (0.73), bilateral coordination (0.84), balance (0.77), running speed and agility (0.88) and strength (0.82). These results were computed using the Pearson correlation between scores from two test sessions and corrected for the variability of the norm group (30).

Inter-rater reliability (41) is the extent to which two different raters obtain the same result from the same test. The Pearson correlation between scores obtained by the two examiners was used to estimate interrater reliability of subtests on the BOT-2 (30). The correlation was adjusted for any biasing effect of the amount of variance of scores in the sample. The interrater reliability coefficients obtained were all sufficient and were as follows: upper-limb coordination (0.98), bilateral coordination (0.98), balance (0.99), running speed and agility (0.99) and strength (0.99) (30).

Based on these results, the BOT-2 can be considered as a reliable measuring instrument of motor skills in preschool children.

2.7.1.2 Validity of BOT-2

Validity is the extent to which a test measures that which it is designed to measure (41), and BOT-2 validity has been supported for content (30). The factor analysis correlation coefficients verify the BOT-2's theoretical structure (30). Cools, De Martelaer, Samaey and Andries (222) reported that, through a product survey and three focus groups, less effective BOTMP items were eliminated and new items were identified to develop the content of the BOT-2. Each of these new items went through a pilot study, a national try out and standardisation (222). The BOT-2 indicated strong relationships with Test of Visual Motor Skills - Revised (TVMS-R), BOTMP and PDMS-2 thereby indicating validity (222).

2.7.1.3 BOT-2 and Research

The Bruininks-Oseretsky Test of Motor Proficiency is a well-established and extensively used test for motor skills development (222). Oseretsky originally developed the test in 1923 in Russia (223). Doll later translated the test into English as the "Oseretsky Tests of Motor Proficiency" (223). The original test had the following weaknesses: gender differences, poor reliability, dangerous test items and confounding of items by intellectual ability (223). Over the years the test was further developed and revised, resulting in the Lincoln-Oseretsky Motor Development Scale (224) and later the Bruininks-Oseretsky Test of Motor Proficiency (225). The BOTMP had improved content, structure and technical qualities but concerns existed regarding item selection and scores (226).

Gwynne and Blick (227) studied the BOTMP in 2004 and argued for its use as the gold standard against which a motor checklist for children with DCD was evaluated due to the test's high validity and reliability. The validity of the BOTMP to assess movement skills in children was supported by Duger, Bumin, Uyanik, Aki and Kayihan (219). However, some studies did not support the divisions of gross and fine motor composites in the BOTMP as the composite scores were found to be unreliable and invalid measures for observing change (228,229). To overcome this weakness, Wilson, Polatajko, Kaplan and Faris (230) suggested that the subtest point scores should be used as a more accurate measure of change as they measure functional gains or deteriorations related to specific areas of motor control.

The BOTMP was revised to remove the aforementioned weaknesses and the latest version, Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), was published in 2005 (30). New activities were added and existing activities were modified in the BOT-2 to improve measurement among four-to-five-year-olds.

The BOT-2 has since been used internationally and is often referred to in scientific literature. Cools et al. (222) highlighted some strengths of the BOT-2 as: age appropriate for preschoolers; a very detailed assessment instrument; being able to separately assess the subtest composites; providing information of skill-mastering both below and above skill level; and the large amount of evidence of psychometric qualities of the test exists. They also highlighted the weaknesses of BOT-2 as: emphasing detection of deficits; missing European normative data; providing a confusing score sheet; requiring a large testing space; and the complete test being too long for young children (222).

In one of the latest studies, Wuang and Su (231) examined the use of the BOT-2 with children with intellectual disabilities. The results indicated an intraclass correlation coefficient (ICC) of 0.99 (95% confidence interval) and an alpha of 0.92 and that the internal consistency of the total scale and test-retest reliability were adequate (231). Wuang and Su found that the responsiveness for all the BOT-2 measures was sufficient except for the balance subtest (231). Taken together, the validity and reliability of the BOT-2 has sufficiently been confirmed by research to support the use of this measuring instrument to assess gross motor proficiency in four-to-six-year-old children.

2.7.2 Scale and Measuring Tape

The children's body mass index was established by measuring all participants' weight (in kilograms) and height (in metres) using a scale and measuring tape. A new digital scale was bought for the purpose of this study and was solely used during the research project. A retractable metal measuring tape was taped vertically to the hard flat wall surface with the base at floor level against which the participants' height was measured in metric units. Participants were measured standing with feet flat on the floor, heels touching the wall, with their back against the wall and the measuring tape. The same scale and measuring tape were used for all the participants during the pre-test and the post-test.

2.7.3 Questionnaires

According to Babbie and Mouton (232), the term questionnaire represents a collection of questions to obtain facts or opinions. Four questionnaires were constructed by the researcher for the purpose of this study. The construction, purpose and pilot-testing of these questionnaires will be reviewed next.

2.7.3.1 Construction Principles of Questionnaires

De Vos (61) highlighted basic principles that needed to be considered when constructing a questionnaire, which were applied in the creation of questionnaires for the current study. The first principle is to know precisely which facts or information is sought after, while keeping it brief (61). For the purpose of this study, general information was needed in order to determine whether a child satisfied the sample selection criteria, such as age, school, informed consent, presence of any medical or neurological illnesses, days absent from school over the research period and therapy received. Information was also required to classify the sample according to gender, perinatal morbidity and physical activity. Additionally, the researcher was interested in feedback from the teachers who presented the SEMOSTI Programme for further development.

The second principle of questionnaire development is that the structure of the study dictates the mode of the questionnaire (61). Structure of the study within this context refers to whether the questionnaires will be e-mailed, posted or telephonically administered, where and under what circumstances and by whom the questionnaires will be completed and how the researcher will ensure compliance.

During this study, all the questionnaires were hand-delivered by the researcher to the respective grade R teachers, who in turn hand-delivered the questionnaires to the parents, who completed them at home. The researcher attended the respective grade R parents' evenings at the start of the year, thereby ensuring an acceptable response rate. This presented an opportunity to explain the purpose and method of this study face-to-face and to encourage the parents to give informed consent and to complete the questionnaires. The class teachers, who had daily contact with the respective parents, also assisted the researcher by handing out questionnaires and by reminding parents to return them on time. All questionnaires were accompanied by a covering letter that served to introduce and explain the questionnaire. The covering letter also included assurance of confidentiality, information regarding the length of the questionnaire, an indication of approximately how long it would take to complete and a deadline for returning the questionnaire to the respective grade R teachers.

The last principle in questionnaire development involves formulating the questions of a questionnaire , such as avoiding leading and biased questions, avoiding negative questions, giving preference to shorter questions, making response categories easy to remember and every question containing one thought (61). For the purpose of this study, the questions were carefully chosen regarding their potential usefulness and sentences were kept concise and clear. A variety of question types were formulated to obtain facts, such as demographic information, and only Questionnaire 4 was constructed to gather opinions, perspectives or attitudes from the three teachers who presented the SEMOSTI Programme over the 30–week period .

2.7.3.2 Purpose and Construction of Questionnaires

- Questionnaire 1: Demographic Questionnaire

The purpose of Questionnaire 1, the demographic questionnaire (Annexure L), was to obtain background information of each participant. The researcher constructed the questionnaire according to the information needed, including date of birth and gender of the child, parental pregnancy information, birth information, health of the child at birth, development of child and medical history. The information gathered through this questionnaire was used to ensure that the children complied with the selection criteria to participate in the study and information was obtained to classify the children according to gender and perinatal morbidity.

For the purpose of this study, the classification of perinatal morbidity was based on the classifications used by Sullivan (136) who investigated the association between perinatal morbidity, mild motor delay and later school outcomes. Sullivan stratified the participants by medical morbidity, taking into account the number of weeks' gestation, birth weight, nature of pregnancy (complicated or uncomplicated), and nature of labour and delivery (complicated or uncomplicated) (136). A similar classification was applied in this study as follows:

- Healthy term infants (≥ 37 week gestation, birth weight > 2500 grams) with uncomplicated pregnancy and uncomplicated labor and delivery (HTI).
- Healthy preterm infants (≤ 37 week gestation) with no significant clinical illness at birth (HPI).
- Term infants with medical illnesses / sickness (≥ 37 week gestation, birth weight <2500 grams) with complicated pregnancy and/or complicated labour and delivery (TIM).
- Preterm infants with medical illnesses / sickness (≤ 37 week gestation) with a significant clinical illness at birth (PIM).

- Questionnaire 2: Physical Activity Questionnaire

The purpose of Questionnaire 2 (Annexure M) was to measure the physical activity of the participants. Various measurement techniques have been designed to measure physical activity in children and tend to be either self-report instruments or objective instruments (78). In the case of young children, the self-report instruments (233), (234) such as questionnaires, are completed by an adult by reporting the child's physical activity. Self- report instruments are easy to administer to large groups, are low-cost, and have valuable educational potential for use in the school curriculum. But validity and reliability pose a problem (233) as self-report instruments in children younger than ten years are not reliable (78).

Bates (78) stated that physical activity can be quantified using objective instruments, which eliminate the influence of socioeconomic status, culture, and recall ability or ethnicity. Pedometers, accelerometers and heart rate monitors are all frequently used in scientific studies as objective instruments of physical activity (78). However, objective instruments such as accelerometers and heart rate monitors are expensive and difficult to use in assessing a large group of children (233). On the other hand, pedometers (233) are easy to use and record distance, but the duration and not the intensity of movement is measured.

Reilly, Coyle, Kelly, Burke, Grant and Paton (235) claimed that measuring physical activity in preschool children is difficult as children who are in preschool are not able to give reliable information regarding their physical activity. Further, parents or caregivers are usually not with children during times of peak activity, and children's days tend to be unstructured, which makes the recall of activity patterns less reliable. They also suggested that motion sensors might not be valid with preschool-aged children and that cut-off points for activity intensities are unknown for this age group (235).

Ideally, the use of questionnaires, together with pedometers, would have provided more reliable data of the activity levels of the participants of this study. However, due to financial constrains, practical logistics with the target group of four-to-six-year-olds, and a lack of age-appropriate standardised physical activity questionnaires, it was decided to develop a non-standard questionnaire to be completed by the parents/caregivers. The questionnaire (Annexure M) was designed to obtain data on the frequency, duration and type of physical activity (78). The questionnaire was divided into three sections. The first section focused on formal physical activities which included moderate to vigorous physical activity (78,188,236). The second section focused on daily physical activity behaviours which included low to moderate physical activity (78,188,236). The third section focused on sedentary screen viewing habits which included stationary activities (78,188, 36).

Formal physical activity included the types and duration of formally organised activities in which the child participated at the time of completing the questionnaire. This section was constructed by listing all the extra-mural activities available in the community, such as tennis, soccer, golf etc., and by allowing space to declare activities not listed. It was completed by indicating the listed formally organised activities in which the child participated, the length of one session in minutes, the number of sessions in a four-week month, and the number of weeks the activity was presented in a 52-week year.

Daily physical activity/inactivity referred to the participants' inherent activity nature. It described the frequency with which the child displayed certain active/inactive behaviours. The parents/caregivers had to complete the daily physical activity section by marking on a zero-to-ten frequency scale (ordinal scaling) how often the child displayed the active or inactive behaviour. For example, "Does your child prefer less physically active play?" The rating scale was as follows:

- Zero indicated never.
- One to three indicated seldom.
- Four to six indicated occasionally.
- Seven to nine indicated frequently.
- Ten indicated that the behaviour was always present.

Eleven out of fifteen questions measured daily active behaviour, while the other four questions measured daily passive behaviour.

Some questions (a to g) listed under this daily physical activity/inactivity section were based on items from the Sensory Profile Caregiver Questionnaire (237) under section I "Modulation of Movement Affecting Activity Level". The remaining questions (h to o) were formulated by the researcher to gather further information regarding daily physical activity behaviour, for example "how often does your child cycle?" and "does your child perform indoor chores?"

Sedentary activity was comprised of the amount of time in a 24-hour day the participant spent screen-viewing. This section was completed by filling in how many hours and minutes the participant watched television and played computer games before school, after school and over weekends per 24-hour day.

- Questionnaire 3: Physical activity Follow-up Questionnaire

Questionnaire 3 was a physical activity follow-up questionnaire (Annexure N). The first part of the questionnaire was an exact copy of Questionnaire 2. Added to this were follow-up questions to determine whether the participant received any therapy over the research period and whether the participant had been absent or ill during school days. Information obtained through this questionnaire was used to classify the participant according to post-test physical activity and to find out whether the participant complied with the exclusive selection criteria.

- Questionnaire 4: Teachers' Feedback Questionnaire

The purpose of Questionnaire 4 (Annexure O), was to gather feedback information from the teachers who presented the programme. This information was used to indicate areas of strength and weakness of the SEMOSTI Programme, to guide future design and development of the programme. The questionnaire was constructed by the researcher based on the following three areas of the SEMOSTI Programme:

1. Weekly format: Information was obtained regarding the Activate, Just-Right challenges, Calming sections and Activity Component Table in terms of instructions, equipment, activites and adaptations. For example, teachers were asked whether the instructions were clear and precise, whether equipment was easily obtainable, and whether there was a selection of different activities.

2. Monthly format: Information was obtained regarding the fourth week repetition cycle and sixteen week evaluation cycle. For example, teachers

were asked whether the selection of activities repeated was adequate, whether the children still enjoyed the repeated activities, whether the number of evaluations scheduled during the course of the programme were sufficient, and whether the time allocated for the evaluation was sufficient.

3. Evaluation of developmental milestones: Information was obtained regarding the form, aspects evaluated, and plan of action. For exampe, teachers were asked whether the instructions were clear and precise, whether the aspects evaluated linked with the aspects listed on the weekly activity component table, and whether the teacher indicated a plan of action for every child.

Questionnaire 4 was compiled of 30 dichotomous questions (i.e., “Yes/No”) with open-ended questions at the end of each of the three sections (e.g., “Any additional comment on the above aspects?”) The advantages of the dichotomous response system are that it is easy and quick to answer and easy to compare results. The disadvantages are that that the teacher can only answer “Yes/No”, thus effectively denying a wide range of possible choices in between (61).

2.7.3.3 Pilot-testing of Questionnaires

According to De Vos (61), all questionnaires that are newly-constructed need to be pilot-tested before use in the research study. For the purpose of this study, the first three questionnaires were completed by three independent individuals as if they were completing them for their own children, and questionnaire 4 was peer-reviewed. The pilot-testing was intended to identify and rectify errors that may hamper the success of this study. The independent individuals identified a few spelling errors, formatting errors and two questions that were vague. Otherwise, the necessary information was obtained as needed to conduct this study.

Modifications were made to the questionnaires before they were presented to the full sample.

2.8 CHAPTER SUMMARY

The need for a sensory-motor stimulation programme was explored by researching the impact that current trends in our society have on the development of children on a motor level. Two main issues were identified, namely a decrease in physical activity and an increase in pathology, which impacts on children's sensory-motor development. Conditions such as overweight/obesity, Type 2 Diabetes, asthma, ADHD, DCD, low muscle tone and preterm birth/birth weight are increasing among children. Section 2.2 validates the school's concern regarding increased motor difficulties among children.

Section 2.3 focused on the impact of delayed sensory-motor development on the areas of occupation of the child to indicate the far-reaching effects of sensory-motor delay. Scientific literature indicated that sensory-motor delay impacted on activities of daily living, school performance and play. With this in mind, section 2.4 highligted the lack of training and resources for grade R teachers in South Africa.

Section 2.5 discussed the development and design of the SEMOSTI Programme. The SEMOSTI Programme is designed as the second draft of the Grade R Programme as a possible intervention strategy. The programme is intended a) to improve motor skills, b) to increase physical activity and c) to inform and guide teachers on early identification of children with sensory-motor difficulties. The programme's foundational theory was analised and priniciples and the design of the manual was reviewed. Section 2.6 motivated the selection of five gross motor skills for the focus of this study. This was followed by a review of the measurement instruments used in this research project in section 2.7. In Chapter 3 the research design and the manner in which the research was conducted are described.

CHAPTER 3 RESEARCH DESIGN AND METHOD

3.1 INTRODUCTION

In this chapter the aim and objectives of this study, which were briefly discussed in chapter 1, will be highlighted. This discussion will be followed by a description of the methodology in terms of the research design that guided this study and a description of the study population. Also included is the application of the measurement instruments that were used to collect data, as well as a description of the procedures of data collection, data recording and data analysis. The limitations of the study regarding the method and measurement instruments, as well as the ethical considerations that were taken into account are outlined.

3.2 THE AIM OF THE STUDY

The aim of the study was to determine the impact that the SEMOSTI Programme had on the gross motor proficiency of four-to-six-year-old children. Given the need for the programme, and the evidence discussed in chapter 2 suggesting that activities like those found in the programme impact childhood development, the following hypotheses were formed.

Null hypothesis: The SEMOSTI Programme does not have a significant impact on the gross motor proficiency of four-to-six-year-old children.

Alternative hypothesis: The SEMOSTI Programme has a significant impact on the gross motor proficiency of four-to-six-year-old children.

3.3 OBJECTIVES OF THE STUDY

In order to reach the aim of the study, gross motor proficiency was measured through motor skills subtests of the BOT-2 (30), which constituted the objectives of the study. In the following section the objectives and hypothesis pertaining to gross motor proficiency are stated, as well as the strengths and weaknesses identified by the three teachers.

3.3.1 Research Objectives Pertaining To Gross Motor Proficiency

3.3.1.1 Objective One

As discussed in the previous chapter (section 2.6), the first objective was to determine whether the SEMOSTI Programme improved the bilateral coordination of the four-to-six-year-old children. Literature provides support that through active practice and experimentation of activities, which require the use of both sides of the body together either as simultaneous or alternating movement, should enhance bilateral coordination skills (10, 182). To speak to this objective, the following hypotheses were posited.

Null hypothesis: The SEMOSTI Programme does not make a significant difference in the bilateral coordination of four-to-six-year-old children.

Alternative hypothesis: The SEMOSTI Programme makes a significant difference in the bilateral coordination of four-to-six-year-old children.

3.3.1.2 Objective Two

As discussed in the previous chapter (section 2.6), the second objective was to determine whether the SEMOSTI Programme improved the balance ability, in particular static and performance balance, of the four-to-six-year-old children. Literature provides support that through active practice and experimentation of activities, which strengthens opposing groups of muscles to sustain postures and maintain body alignment, should enhance balance skills (10, 182). To speak to this objective, the following hypotheses were posited.

Null hypothesis: The SEMOSTI Programme does not make a significant difference in the balance ability of four-to-six-year-old children.

Alternative hypothesis: The SEMOSTI Programme makes a significant difference in the balance ability of four-to-six-year-old children.

3.3.1.3 Objective Three

As discussed in the previous chapter (section 2.6), the third objective was to determine whether the SEMOSTI Programme improved the running speed and agility of the four-to-six-year-old children. Literature provides support that through active practice and experimentation of activities, which improves body coordination, quickness and speed, should enhance running speed and agility (10, 182). To speak to this objective, the following hypotheses were posited.

Null hypothesis: The SEMOSTI Programme does not make a significant difference in the running speed and agility of four-to-six-year-old children.

Alternative hypothesis: The SEMOSTI Programme makes a significant difference in the running speed and agility of four-to-six-year-old children.

3.3.1.4 Objective Four

As discussed in the previous chapter (section 2.6), the fourth objective was to determine whether the SEMOSTI Programme improved the upper-limb coordination of the four-to-six-year-old children. Literature provides support that through active practice and experimentation of activities, which improves eye hand coordination and should girdle stability, should enhance upper limb coordination skills (10, 182). To speak to this objective, the following hypotheses were posited.

Null hypothesis: The SEMOSTI Programme does not make a significant difference in the upper-limb coordination of four-to-six-year-old children.

Alternative hypothesis: The SEMOSTI Programme makes a significant difference in the upper-limb coordination of four-to-six-year-old children.

3.3.1.5 Objective Five

As discussed in the previous chapter (section 2.6), the fifth objective was to determine whether the SEMOSTI Programme improved the strength of the four-to-six-year-old children, which included arm and shoulder strength, abdominal strength and leg strength. Literature provides support that through active practice and experimentation of activities, which requires moving against resistance, should enhance strength skills (10, 182). To speak to this objective, the following hypotheses were posited.

Null hypothesis: The SEMOSTI Programme does not make a significant difference in the strength of four-to-six-year-old children.

Alternative hypothesis: The SEMOSTI Programme makes a significant difference in the strength of four-to-six-year-old children.

3.3.2 Research Objective Pertaining To the Strengths and Weaknesses of the SEMOSTI Programme As Perceived by the Three Teachers

As discussed in the previous chapter (section 2.5), it is necessary to review the programme as part of the development and design process of a new intervention. The objective is to identify the strengths and weaknesses of the SEMOSTI Programme as perceived by the three teachers who implemented the programme over the 30-weeks period. The feedback will aid in the revision and refinement of the content of the SEMOSTI Programme.

3.4 METHODOLOGY

3.4.1 Research Design

A quantitative approach was used in this study. Specifically, a field experiment was conducted using a quasi-experimental comparison group pretest-posttest design (61). Quantitative research entails testing relationships between variables (238). This design was implemented in this study to quantify and testing the relationship between the SEMOSTI Programme and the gross motor proficiency of the children. Measurements were taken, intervention was carried out for 30 weeks and then subsequent measurements were retaken to determine the impact of the intervention.

Fraser and Galinsky (57) stated that a randomised design trumps all other measurement and data analysis issues in intervention research. Random sampling is ideal for quantitative research because it ensures that the sample is representative of the population (61), however it was not possible in this study because of practical and ethical problems. Therefore, a convenience sample was used which included two comparable schools as intact groups (one school acted as an experimental group and the other school acted as a control school) and all the grade R learners who satisfied the selection criteria were included. The lack of randomisation is a limitation to this study and placed this research design in the quasi-experimental category.

Although a quasi-experimental design is not ideal, Flay (156) stated that this design is more common in medical, social and educational research due to practical problems and issues regarding ethics and informed consent. According to Flay (156), the National Cancer Institute (NCI) and National Heart, Lung, and Blood Institute (NHLBI) both recommend eight phases of research for a health promotional programme of which the pilot applied research and prototype studies are conducted on a small sample with a quasi-experimental design. The quasi-experimental design is more feasible, easier to set up than true experimental designs and is efficient in longitudinal research over longer time periods (61). The pilot study would then be followed by efficacy and effectiveness studies on a large sample with experimental designs (156).

Random sampling is necessary to address confounding variables (155). Due to a lack of randomisation, groups were compared at the start of the study to determine if they matched, and if they did not match statistical adjustments were made accordingly. This will be discussed in more detail in section 3.6.3.

The pretest-posttest control group design was used to ensure internal validity. Internal validity refers to the extent of taking into account alternative explanations for any causal relationships relevant to the study (61). Therefore, a control group (238) was used to overcome possible influence of outside variables at the start and the end of the study, which could influence the results. Both the experimental and control groups underwent the same tests at the same time, however the control group did not participate in the SEMOSTI Programme.

3.4.2 Study Population

The study population consisted of 156 white, Afrikaans-speaking, grade R learners in two mainstream schools on the West-Rand, Gauteng province. The two schools were selected through purposive sampling. Two schools were included to ensure a larger sample, rather than only using participants in the same school and dividing them into experimental and control groups, thus reducing the sample by half.

The school that initially requested the stimulation programme was selected as the experimental group due to the teachers' previous experience with the Grade R programme and their willingness to adhere to the programme manual. The school was willing and committed to the process of designing and developing the programme. A control school group was identified in the neighbouring suburb.

The two schools were situated about four kilometers from each other and were similar in regard to the Afrikaans medium, and being comprised of mostly white learners from middle to high-income groups. Further, both schools offered learners access to the same extra-mural opportunities in terms of netball, rugby and gymnastics. Children from both schools had access to community leisure activities such as ballet, cricket, golf, judo, monkeynastics, playball, tennis and swimming lessons. Finally, both schools initially had grade R teachers planning and presenting physical activities as part of the grade R curriculum without following a specific programme. However, the one school implemented the Grade R Programme in 2006, as discussed section 1.2.

The main difference between the two schools was that the teachers at the experimental school would now present the SEMOSTI Programme to the new grade R learners who started the year at the school. The teachers at the control school did not follow any specific programme to improve motor skills or increase physical activity, but the teachers of the control group planned and presented random physical activities for 30 minutes three times a week as part of the typical grade R curriculum. This inclusion of physical activity is a possible limitation of the study and will be discussed further under section 3.7.1.

The experimental school group consisted of three grade R classes with 78 learners in total [teacher/class 1 (T1) = 26 learners; teacher/class 2 (T2) = 28 learners; teacher/class 3 (T3) = 24 learners] in 2008. The control school group also consisted of three grade R classes with 78 learners in total [each class consisted of 26 learners] in 2008.

Two of the three teachers (T1 and T2) had implemented the first draft (Grade R Programme) in previous years while the third teacher (T3) was newly appointed to the school and therefore new to the programme. Teacher T1 had 7 years of teaching experience of which most experience were gained at this particular school. Teacher T2 was a young teacher with two years of teaching experience, which was gained at this school. Teacher T3 was newly qualified and started her first year at this school.

Given the demographics of the two groups, the researcher assumed that the population would be fairly homogenous. Although, three different teachers implemented the programme, this possible variable was taken into account.

3.4.2.1 Selection Criteria

The following criteria were applied in the selection of suitable participants for this study:

- The children had to be in grade R in 2008 at the control and experimental schools;
- They had to be between the ages of four and six years;

- The parents or caregivers had to provide informed consent to allow the learners to participate.

The following exclusion criteria were applied:

- The children must not have had compromised motor proficiency due to a medical or neurological illness or disorder (such as hemiplegia, cerebral palsy, or muscular dystrophy).
- The children must not have been ill or absent for an extended period (more than a month) during the research project or have had a serious physical injury that could have compromised their motor proficiency during the research project.
- The children must not have been receiving occupational therapy or physiotherapy at the start of, or during, the research project.

3.4.2.2 Sample Size

The study was completed on a total of 73 grade R learners. Of the 156 informed consent forms sent out in total to both schools at the start of the year, 102 were returned of which only 100 grade R learners satisfied the selection criteria. Due to questionnaires not being returned, participants being absent on the days of testing, questionnaires being incomplete due to missing data and participants moving away from the respective schools during the study, only 73 participants' data were statistically analysed and reported on in this study.

3.4.2.3 Description of Sample

The sample consisted of the following:

- 73 (100%) white, Afrikaans-speaking, grade R learners in two mainstream schools on the West-Rand, Gauteng province;
- 38 learners of the control group (52%) and 35 learners of the experimental group (48%);

- 40 female learners (55%) and 33 male learners (45%);
- 6 four-year-olds (8%), 62 five-year-olds (85%) and 5 six-year-olds (7%) with a mean age of 5 years 5 months at the start of the study.

3.5 MEASUREMENT INSTRUMENTS

Measurement is the process of observing and recording the observations that are made as part of a research effort (239). The following measurement instruments were used to collect data for this study as discussed in section 2.7.

3.5.1 The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)

Each avaliable participant of the sample was tested in the pre-test and post-test with the motor skills subtests (30), namely upper-limb coordination, bilateral coordination, balance, running speed and agility and strength. The validity and reliability of this test has been established empirically and was discussed in section 2.7.

Each of the five subtests consisted of five to nine items. The participant's performance on each item was recorded as a raw score on the Data Record Form (Annexure P); for example, if the child was able to drop and catch a ball with two hands three out of five times, this resulted in a raw score of three. A raw score varied between a number of points, a number of correct activities performed or a number of seconds. After recording the participant's raw score for each item on the subtest, it was converted into a point score. A point score is a type of standard score that allows a participant's item performance to be evaluated on a graded scale (30). The point scores of each individual item were added to compute the subtest's total point score. If the complete BOT-2 assessment was conducted, all the total point scores would be added to compute a Total

Motor Composite (30). However, for the purpose of this study, only five subtests were conducted and the total points scores of these subtests were added to compute a total gross motor proficiency raw score.

The total point scores for each subtest of each participant were entered into the BOT-2 ASSIST software and converted to a scale score (30). A scale score relates the participant's performance to the performance of a relevant reference group (i.e. individuals from across the United States) containing a representative sample of individuals who are approximately the same age of the participant (30). The BOT-2 ASSIST software uses separate norms for boys and girls and norms vary across age groups with a 3-month interval from four-to-seven years, a 6-month interval from eight-to-thirteen years and a 12-month interval from fourteen-to-twenty-one years (30). The five subtests' scale scores were added to compute a total gross motor proficiency scale score.

The researcher was committed to objective scoring and meticulous/strict/precise administration as it was important to ensure reliability and validity of the data generated through the BOT-2 test. Hopkins stated (238) that ideally independent examiners should blindly administer the pre-test and post-test. In a blind study neither the examiners nor the participants are aware of which group is the experimental group and which the control group (238). However, due to the financial and practical implications of recruiting external examiners, blind testing was not possible. Instead, two strategies were put into place to curb possible bias. Firstly, an independent occupational therapist, who was familiar with the BOT-2, administered 11% (8 out of 73) of the post-tests. Four participants of the experimental group and four participants of the control group were assessed by the independent examiner. The independent examiner had no personal interest in this study and was thus deemed objective. The independent examiner was aware of which schools were experimental and control groups.

A second measure to curb bias was to digitally record the post-tests of all participants (both experimental and control groups). This was done for practical reasons in order for an independent examiner to check the administration and scoring of the BOT-2. Another independent occupational therapist randomly sampled the recordings, investigated 10% (7 out of 73) of the post-tests and critically examined the administration, specifically the procedure and scoring of each item. The researcher drew up a form for this purpose (Annexure R). The independent examiner checked the appropriateness of the physical testing environment, the test equipment, the researcher's rapport with the participants, and each subtest in terms of procedure, administration rules and scoring where possible.

The results of this review indicated that the two physical testing environments were adequate in terms of lighting, furniture, and size and the spaces were relatively free from noise and other distractions. The testing equipment were adequate at both test sites in terms of the throwing line, target height, and availability of balance beam, tennis ball, tape measure, knee pad and stop watch. It was concluded that the researcher established and maintained a positive and encouraging rapport with all participants and that no administration or scoring mistakes were apparent. The independent occupational therapist found the scoring to have been objective and the test properly administrated based on the seven cases reviewed.

3.5.2 Scale & Measuring Tape

The weight (in kilograms) and height (in metres) of each child participating in the study were measured at the pre-test and post-test. The participants were weighed and measured fully clothed but without shoes or bulky clothing such as jackets. The measuring tape was secured vertically to a smooth flat wall with smooth flooring. Participants were measured standing with feet flat on the floor, heels touching the wall with their back against the wall and measuring tape and with arms against sides and facing to the front. A measurement was taken by placing a hardback book on their heads flat against the wall and measuring tape. Readings were double-checked before they were recorded. The BMI was calculated for each of the participants by weight (in kilograms) divided by height (in metres squared).

3.5.3 Questionnaires

3.5.3.1 Questionnaire 1: Demographic Questionnaire

The parent/caregiver of each participant completed Questionnaire 1. Questionnaire 1 was used to collect demographic information and information regarding pregnancy, birth, health of newborn, developmental milestones and medical history. Data was used to categorise participants according to gender, age and perinatal morbidity categories, namely healthy term infants (HTI), healthy preterm infants (HPI), term infants with medical illnesses / sickness (TIM) and preterm infants with medical illnesses / sickness (PIM).

3.5.3.2 Questionnaire 2: Physical Activity Questionnaire

The parent/caregiver of each participant completed Questionnaire 2 at the start of the study, which was used to collect information regarding physical activity. The learners' participation in formal organised activities (i.e. soccer, tennis, netball etc.), daily physical activity behaviours (i.e. spend time n passive play, prefer physically active play, perform outdoor chores etc.) and time spend per 24-hour day in sedentary screen watching (i.e. TV, computer games, Play station etc.) was recorded.

A formal physical activity score was computed by adding the value of all 15 activities. Each activity score was calculated by multiplying the number of minutes per session by the number of sessions per week, and then by the number of weeks the activity was presented over a 52-week year. Children with formal physical activity scores of <7680 were classified as below median for formal physical activity and scores of >=7680 as above median for formal physical activity (7680 was the median for formal physical activity score i.e. 50% of the children scored below and 50% above this value). The mean for formal physical activity was 10441.2 and mode 2160.0.

To enable the computation of a daily physical activity score, first the four scores indicating inactive behavior had to be statistically reversed to measure active behavior. Then the average or mean was calculated for these 15 behaviors. This resulted in a final daily physical activity score for each subject. Children with daily physical activity scores of <5.9 were classified as below median for daily physical activity and scores of >=5.9 as above median for daily physical activity (5.9 was the median for daily physical activity score; i.e. 50% of the children scored below and 50% above this value). The mean for daily physical activity was 5.8 and the mode was 4.3.

In computing a sedentary activity score for each subject, all the data were converted into minutes and all the minutes were added. In this manner the total amount of minutes that a child was watching TV and/or playing computer games was calculated. The classification was reversed so that children with sedentary activity scores of <=900 were classified as below median (less screen viewing = more physically active) for sedentary activity and scores of >900 as above median (more screen viewing = less physically active) for sedentary physical activity (900 was the median for sedentary physical activity score; i.e. 50% of the children scored below and 50% above this value). The mean for sedentary activity was 1008.6 and the mode was 1620.0.

Data were used to categorise participants at the start of the study as formally physically active above or below median, daily physically active above or below median, and sedentary active above or below median.

3.5.3.3 Questionnaire 3: Physical activity Follow-up Questionnaire

The parent/caregiver of each participant completed Questionnaire 3 at the end of the study, which was used to collect information regarding physical activity. The children's' participation in formal organised activities (i.e. soccer, tennis, netball etc.), daily physical activity behaviours (i.e. spend time n passive play, prefer physically active play, perform outdoor chores etc.) and time spend per 24-hour day in sedentary screen watching (i.e. TV, computer games, Play station etc.) were recorded at the end of the study.

Data were used to categorise participants at the end of the study as formally physically active above or below median, daily physically active above or below median, and sedentary active above or below median. The same method was used as with the data collected through Questionnaire 2.

3.5.3.4 Questionnaire 4: Teachers' Feedback Questionnaire

Questionnaire 4 was completed by the three teachers who implemented the SEMOSTI Programme at the end of the 30-week period. Data was received regarding the weekly format, monthly format, and evaluation of developmental milestones section.

The teachers' responses were classified as a possible strength or weakness, with "Yes" indicating a positive response/agreement and "No" indicating a negative response/disagreement. Additional comments were interpreted carefully and reported.

3.6 PROCEDURE

3.6.1 Data Collection

The data collection process was conducted in three stages (summarised in Figure 3-1).

STAGE 1 – January 2008

- Questionnaire 1 was completed by parents/caregivers.
- A sample of 100 subjects was selected.

STAGE 2 - February 2008

- While Questionnaire 2 was completed by parents/caregivers, the BOT-2 pre-test was administered.
- Weight and height were measured.
- The SEMOSTI Programme was implemented at the experimental group school for a 30-week period.

STAGE 3 – October 2008

- While Questionnaire 3 was completed by parents/caregivers, the BOT-2 post-test was conducted.
- Weight and height were measured.
- Questionnaire 4 was completed by the three Grade R teachers at experimental school.

Figure 3-1 Summary of Data Collection Process

Stage 1

On 14 January 2008, informed consent forms and Questionnaire 1 (Annexure L) were handed out to all 156 grade R parents of both control and experimental schools. The parents/caregivers completed the consent forms and Questionnaire 1 and returned the completed forms to the class teacher. The grade R heads of each school collected all the completed forms and submitted them to the researcher.

A total of 102 questionnaires were returned with informed consent from both schools. However, two children were excluded due to receiving occupational therapy intervention. The remaining 100 participants who satisfied all the selection criteria were accepted. An initial even distribution of male and female participants and of experimental and control groups were obtained.

Stage 2

Questionnaire 2 (Annexure M) was handed out on 16 January 2008 to all participants, the same day the BOT-2 pre-test was conducted. Questionnaire 2 was completed by the parents of the participants in the sample. The researcher gave Questionnaire 2 to the respective teachers to be handed to the 100 participants. The parents/caregivers completed the forms at home and returned them to the teachers. The grade R heads of each school collected and returned the questionnaires to the researcher. Of the 100 questionnaires handed out, only 83 were returned.

The researcher administered each of the five subtests of the BOT-2 to the participants during the pre-test, though one child was absent on the day of testing. Data were recorded on the Data Record Form (Annexure P) as participants were tested individually during school hours at their respective schools. Both schools provided a noise-free testing area. The running course was carefully measured and taped on each day of testing, the position of the wall target was adjusted to eye level for each child and the throwing line was carefully measured and taped onto the floor. An open, honest and friendly rapport was established with all the children prior to the test. The children were encouraged to put forth their best effort (30).

The weight in kilograms and the height in meters of the participants were recorded during the BOT-2 pre-test. This information was used to calculate the body mass index (BMI) for each participant (35).

On 28 January 2008 the SEMOSTI Programme was implemented for the first time with the experimental group, and recurred over a 30-week period. The SEMOSTI Programme was designed to be presented over 40 weeks of the school year, however 3 weeks were used in the beginning of the year to hand out Questionnaire 1 and Questionnaire 2 and to conduct pre-tests. Further, the post-tests took 2 weeks to conduct and the fourth term tends to be a busy term with nativity play practice and school outings. Therefore, only 30 weeks out of the 40-week SEMOSTI Programme was investigated (Week 1 to Week 30).

The three teachers began presenting Week 1 Day 1 on 28 January 2008 as was written in the SEMOSTI Programme manual. SEMOSTI Programme alert, just-right challenges and calming activities were presented daily for 45 minutes for five days of the week, excluding holidays. The Week 30 Day 1 activities were implemented on 6 October 2008.

Each of the three teachers presented the same SEMOSTI Programme activities daily as written in the manual at the same time of the day. They indicated on a calendar (Annexure Q) if they were able to present the alert, both just-right challenges and calming activity daily. Therefore, all three teachers were giving the same intervention in a similar fashion with similar equipment as written in the manual.

All children attended the school regularly and had adequate exposure to the SEMOSTI Programme. They were on average 4.45 days absent from school over the 30-week period.

Stage 3

After the 30-week period on 6 October 2008, Questionnaire 3 (Annexure N) was given to the teachers to be dispersed to the parents/caregivers of the sample while BOT-2 post-tests were conducted. After completing Questionnaire 3, the parents/caregivers returned them to the teachers who passed them on to the grade R head of each school, from whom the researcher received them. Of the participants, five have moved away over the 30-week period and were no longer attending the respective schools.

Questionnaire 3 was handed out to the remaining participants as the questionnaire included the exclusive selection criteria. Of the questionnaires handed out, only 73 were returned.

The BOT-2 post-tests were administered to the remaining participants while Questionnaire 3 was being completed and returned by parents/caregivers. Each of these children was weighed and measured.

The three teachers at the experimental group school completed Questionnaire 4 (Annexure O) after the 30-week period of implementing the SEMOSTI Programme to give feedback on the programme.

All participants BOT-2 pre- and post -raw scores were entered into the BOT-2 ASSIST software which generated score profiles and a report identifying the participants' motor skill strengths and weaknesses. At the end of the study, each participant received a computer generated BOT-2 report with the pre-test and post-test results (Annexure S).

Implementation fidelity

Trochim stated that a theory-driven approach to quasi-experimentation would be futile unless one could demonstrate that the intervention was implemented as the theory intended (239). Consequently, certain measures were put into place to ensure that the three teachers implemented the SEMOSTI Programme as the manual instructed.

The measures included an hour of training in the implementation of the SEMOSTI Programme before the start of the study (25 January 2008). The researcher used the training to work through the manual of the SEMOSTI Programme in order to familiarise the three teachers with the format and requirements. The SEMOSTI Programme was fully manualised and each teacher received a manual at the researcher's cost. The researcher ensured that the experimental school had all the necessary equipment as needed.

Follow-up visits were conducted at the school every 10 weeks over the 30-week period of the study for support. All three teachers followed a 30-week schedule based on a calendar to ensure that they presented the same activities on the same days (Annexure Q). This was accomplished by ticking off daily on a calendar when the teachers presented the Alert, Just-Right Challenge and Calming sections. On average the teachers managed to present 80.33% of the SEMOSTI Programme according to the SEMOSTI Programme manual over the 30-week period (teacher T1 implemented 81%, teacher T2 implemented 78% and teacher T3 implemented 82%).

Possible failure to present the programme on a given day could have been due to an organised outing, watching a visiting show at the school, taking school photos or practising for a school play. These types of activities would disrupt the normal school day plan and the SEMOSTI Programme would be omitted for that day.

3.6.2 Data Recording

Measurements used in this study included scores obtained from subtests of a standardised test for motor proficiency, weight and height measurements and data collected from questionnaires. The data was recorded as follows:

- BOT-2 raw scores (total point score) were recorded on the data record form of each participant. The total point scores were converted to scale scores through computer scoring. The pre-test and post-test raw scores and scale scores were recorded on a data spreadsheet.
- Weight (kg) and height (m) were recorded and converted to BMI using the formula {Weight in Kilograms / (Height in Meters x Height in Meters)}. The pre-test and post-test BMI were recorded on a data spreadsheet.
- Data from Questionnaire 1 were used to classify participants according to age, gender and perinatal morbidity which were recorded.
- Data from Questionnaire 2 were used to classify participants according to formal physical activity above or below median groups, daily physical activity above or below median groups and sedentary above or below median groups at the start of the study.
- Data from Questionnaire 3 were used to classify participants according to formal physical activity above or below median groups, daily physical activity above or below median groups and sedentary above or below median groups at the end of the study.
- Data from Questionnaire 4 were used to classify the three teachers' responses as a strength or weakness.

Table 3-1 demonstrates the levels of measurement of the data that were collected.

Table 3-1 Levels of Measurement

Measurement Instrument	Level of measurement
BOT-2	Interval scale
Scale & Measuring Tape	Ratio scale
Questionnaire 1	Nominal scale
Questionnaire 2	
Questionnaire 3	
Questionnaire 4	

3.6.3 Data Analysis

Data were analysed by the Department of Statistics at the University of Pretoria under the guidance of a statistician of the Faculty of Health Sciences. Different statistical analysis techniques were applied to test the hypotheses. In Table 3-2 the process and methods for data analysis are summarised.

Table 3-2 Process and Method of Data Analysis

Process of Data Analysis	Method of Analysis
Step One (BASELINE): To compare the experimental and control groups to determine if the two groups are comparable at baseline. First, the experimental group as a whole is compared to the control group. Then the experimental subgroups are compared to the control group.	Basic descriptive statistical measures (mean, proportions and standard deviations). Table 4-1: ▪ T-test (age and BMI) ▪ Chi-square test (gender and physical activity) ▪ Fisher's exact test (perinatal morbidity) Table 4-2: ▪ Kruskal-Wallis test (age and BMI) ▪ Fisher's exact test (gender, perinatal morbidity and physical activity)
Step Two: To compare the post-test results of the experimental and control groups to determine the change in gross motor proficiency over the 30-week period.	GLM procedure
Step Three: To determine if the 3 teachers (active group) achieved significant post-test results compared to the control group over the 30-week period	GLM procedure and Dunnett's t-test

The data were analysed in three steps. Step 1 compared the experimental and control groups at pre-intervention to determine if the two groups are comparable at baseline using descriptive data (mean, proportions and standard deviation). Eight variables were taken into account i.e. age, gender, BMI, perinatal morbidity, formal physical activity, daily physical activity, sedentary activity, and the pre-test scores for total gross motor proficiency in terms of total point raw and scale scores. T-test, Chi-square test and Fisher's exact test and Kruskal-Wallis were used to test for any significant differences (240).

Step 2 compared the post-test results in motor proficiency between the experimental and control groups over the 30-week period. Both the total point raw and scale scores were analysed. Adjustments were made for inequalities between the experimental and control groups using the GLM procedure (adjusting for perinatal morbidity, age and gender).

Lastly, step 3 compared the post-test results of the three different teacher groups of the experimental group each with the control group to determine if it was significant over the 30-week period. The Dunnett's t-test was used to analyse for significant differences. The Dunnett's t-test is a post hoc test (or multiple comparison test) that can be used to determine the significant differences between a single control group mean and the remaining treatment group means in an analysis of variance setting (241). Adjustments were made for multiple testing.

The data collected through Questionnaire 4 was not statistically analysed. The teachers responses were classified as a possible strength or weakness, with "Yes" indicating a positive response/agreement and "No" indicating a negative response/disagreement. Additional comments were interpreted carefully and reported in the results.

3.7 LIMITATIONS

3.7.1 Limitations of Study's Method

The lack of randomised sampling is a limitation to the methodology of the study. Randomisation is necessary to address confounding variables which could produce changes in gross motor proficiency which may be interpreted as a result of the SEMOSTI Programme (61). This limitation was addressed by making statistical adjustments for the inequalities between the experimental and control groups. However as discussed in section 2.5, this study was a pilot test of an early version of the SEMOSTI Programme for which a quasi-experimental research design was more practical (156). Future efficacy and effectiveness trials would require pure experimental research designs (156).

The lack of blind testing is another limitation to the methodology. Ideally the person administrating the subtests of the BOT-2 should not have known which children belonged to the control or experimental groups. Blind testing would have eliminated possible bias which could invalidate the results. However, due to financial constraints it was not possible to contract a trained therapist to administer the tests. And therefore, the researcher had to administer the tests.

The limitation of a smaller scale research study affected the extent to which the findings can be generalised. However, it is suggested that pilot tests are done on a small scale, which lead to further development of the intervention programme while effectiveness trials of a more final version of the intervention programme are conducted on a large scale (156). Ideally, the study should have been conducted at grade R classes at multiple schools across South Africa. As mentioned in section 2.4, there were an estimated 14 000 grade R classes countrywide with approximately 490 000 grade R learners in South Africa during 2008 (152). For a population of 490 000, a 1% sample would have required 4900 participants to be included in the study which was out of the scope of the researcher's budget.

An additional limitation to the methodology of this study is that the sample only included white, Afrikaans-speaking learners from two mainstream schools on the West-Rand, Gauteng. Including children representative of the different race and language groups found in South Africa, as well as including both urban and rural communities, would have been ideal. The representation and size of this sample would enable the findings to be generalised to all four-to-six-year-olds in the country. Unfortunately, due to cost, logistics and manpower limitations a smaller scale research project was conducted.

A limitation to a field study is the extent to which one can control outside variables. The experimental and control groups were chosen as close to similar as practically possible. However, the researcher had no control over the amount and frequency of physical activity of the children, their body mass index, their diet, the type and number of sport activities participated in over the 30-week period, or time spent screen viewing. Ideally, either the control group should not have had the physical activities as presented by the teachers, or the experimental group should also have had the physical activities as presented by the teachers in addition to the SEMOSTI Programme. Both these options were not possible as it would have been unethical to stop the physical activities at the control school and it would have been impractical to expect the experimental school to allocate that amount of time of the curriculum in a day to motor development. Therefore the comparison group pretest-posttest design was implemented while taking into account factors influencing gross motor proficiency such as physical activity, body mass index, gender and perinatal morbidiy in the analysis of data as to draw more reliable conclusions. This limitation may have influenced the validity and reliability of the study's outcome.

Additionally, the researcher implemented strategies to ensure that the teachers presented the SEMOSTI Programme daily as the manual instructed. However, the researcher had no real control over the quantity or quality of presentation of the SEMOSTI Programme. The three teachers were different. They differed in age, years of experience, training and in personality (enthusiastic and energetic compared to a more serious personality) which could impact the results of the study.

3.7.2 Limitations of Measurement Instruments

- Questionnaire 1

Some parents found it difficult to remember the birth weight and age in months when their child reached the developmental milestones for sitting, crawling and walking. Therefore, some data were absent on the questionnaire. However, the data that were obtained proved adequate for the purpose of this study to determine whether a child satisfied the selection criteria and to classify children according to perinatal morbidity.

- Questionnaire 2

A limitation of this study was the absence of a standardised questionnaire for parents to assess the levels of physical activity of the children. Questionnaire 2 was not a standardised measuring tool, which resulted in the participants' physical activity being compared to the sample's physical activity instead of a . In this way, an indication of the participants' physical activity was obtained, but standardised classification was lacking.

The completion of the formal physical activity section also proved challenging. Parents were not always aware of the length of one session (for example, how long a session for swimming lessons took), or how many sessions a child would attend in a year. This resulted in a wide range of responses, which made the processing of data difficult.

- Questionnaire 3

The weakness of the data provided by Questionnaire 2 applies similarly to the physical activity data obtained through Questionnaire 3. The additional follow-up information, in terms of the number of days the participant was ill or absent from school, proved adequate to be able to determine whether any participants should be excluded from this research project.

- Questionnaire 4

Questionnaire 4 consisted of mainly dichotomous questions, which might cause the responder to be of the opinion that their viewpoint is not represented by the two options given. Therefore, the feedback questionnaire might have lacked detail and be potentially bias. Continuous process notes made by the teachers and feedback after each session would have provided more in-depth feedback however, this is impractical over such a long time period.

3.8 ETHICAL PROCEDURE

De Vos (242) stated that "researchers have two basic categories of ethical responsibility: the responsibility to those human and nonhuman, who participate in a project; and responsibility to the discipline of science, to be accurate and honest in the reporting of their research". The following ethical principles were considered and applied during this research.

3.8.1 Avoidance of Harm

The participants of this study were not harmed in any way, be it physically or emotionally, while being tested or by participating in the SEMOSTI Programme (242). Participation in the SEMOSTI Programme and BOT-2 testing required physical activity which could possibly result in physical injury. However participation involved only minimal risk associated with everyday life, such as running, rolling, kicking or throwing. Both the control and experimental schools were equipped with first aid as part of the school set-up.

As discussed in section 2.5.3, the manual listed precautions for selected activities, for example, the alert activity where children are spinning themselves in circles, teachers were cautioned to only let children spin in circles as the child felt comfortable doing, precautions were given for activities requiring rotational movement to be aware of children getting over stimulated and precautions when stretching. Specific therapeutic techniques were not prescribed as activities did not require specialised equipment or passive handling.

3.8.2 Informed Consent

All parties involved were given accurate and complete information so that they could make an informed decision to participate in this study (243). This was done as follows:

- Schools

The researcher had personal interviews with principals of both schools, providing practical information. Both the principal and the chairperson of the governing body of each school signed the informed consent document (Annexure H) accompanied by a letter which described the data collection process. The grade R classes fell under the management of the school governing bodies and were not connected to the Department of Education at the time of the study.

- Grade R Teachers

The researcher also conducted interviews with the grade R coordinators of both schools providing practical information. All the grade R teachers at both schools signed the informed consent document (Annexure I) accompanied by a letter which described the data collection process.

- Grade R Children

The researcher attended the grade R parent evenings of both schools in January 2008. During these meetings, the researcher had the opportunity to personally give accurate and complete information about the planned research project to all the grade R parents. Informed consent forms, accompanied by a letter of explanation, were handed out to all grade R children at both schools (Annexure J). Only children whose parents gave informed consent participated in the research. The activities were verbally explained to the four-to-six-year old participants who gave verbal assent.

3.8.3 Deception of Participants and/or Respondents

No form of deception was inflicted on respondents. Facts were presented accurately and openly to all participants.

3.8.4 Violation of Privacy/Anonymity/Confidentiality

No participants' privacy, confidentiality or anonymity was violated at any point during the study (242). The results of each individual participant were kept private by allocating a participant number to each child. Each participant's individual results were made known only to the parents of that child at the end of the study.

3.8.5 Actions and Competence of Researcher

The researcher was adequately qualified and equipped, and there was adequate supervision of this project throughout its implementation. The research proposal was first presented at the Department of Occupational Therapy at the University of Pretoria's scaffolding meeting on 9 February 2007. A research protocol was then prepared and reviewed by the Post-graduate Committee of the School of Health Care Sciences at the University of Pretoria in October 2007.

Once the protocol was reviewed, it was presented to the Ethics Committee of the Faculty of Health Sciences at the University of Pretoria for input and approval. The research project was approved by the Ethics Committee (certificate number S217/2007) (Annexure K). The original title of the dissertation was changed to the current one and this change was approved by the Ethics Committee.

3.8.6 Justice

A copy of the SEMOSTI Programme was presented to the school of the control group after the study. The basic principles of the SEMOSTI Programme were briefly explained to the Head of the grade R teachers if they were interested in implementing the programme at the school.

The participants each received a computer generated BOT-2 report at the end of the study which contained the score profiles and identified the participant's motor skill strengths and weaknesses (Annexure S). Participants were given an invitation to contact the researcher if they had any further queries.

3.8.7 Release or Publication of the Findings

The findings of this research study were documented accurately and objectively in this dissertation. The results of the pilot test of the SEMOSTI Programme will be submitted for possible publication to the South African Journal of Occupational Therapy. It will also be beneficial to publish an article in a journal accessible to educators. The SEMOSTI Programme will need to undergo further research with efficacy and effectiveness trials before it is published and marketed as indicated by step 5 of the intervention research process (57).

3.9 CHAPTER SUMMARY

This chapter explained the steps taken in order to reach a conclusion regarding the research problem. The study's aim and five objectives pertaining to gross motor proficiency were stated. Six hypotheses regarding the impact that the SEMOSTI Programme had on the gross motor proficiency of four-to-six-year-old children were formulated. Objectives pertaining to variables associated with the development of motor proficiency in children and to the development of the SEMOSTI Programme were stated. A quantitative, quasi-experimental, comparison group pretest-posttest research design was applied to test the research hypotheses. Measurement instruments, comprising of questionnaires, subtests of a standardised test and scale and measuring tape, were used to gather research data. The data were collected, recorded and analysed using different statistical analysis techniques to draw reliable conclusions. The chapter ended with a discussion on limitations of the study method and measurement instruments and the ethical procedure that was followed. The research results will be discussed in Chapter 4.

CHAPTER 4 RESEARCH RESULTS

4.1 INTRODUCTION

The aim of this research project was to determine the impact that the SEMOSTI Programme had on the gross motor proficiency of four-to-six-year-old children. In this chapter, the results that were obtained and the interpretation thereof will be discussed. Section 4.2 compares the experimental and control groups at pre-intervention. The research aim and objectives pertaining to gross motor proficiency are discussed in section 4.3. Section 4.4 reviews the research objective pertaining to the evaluation of the SEMOSTI Programme. The chapter ends with a summary of the main results.

4.2 COMPARING EXPERIMENTAL AND CONTROL GROUPS AT PRE-INTERVENTION

In this section, the experimental group is compared with the control group. The purpose of this comparison is due to the lack of randomisation in the sampling methods. In a randomised trial participants are assigned to the groups based on chance and the groups are considered to be as similar as possible at the start of the study (61). Due to a lack of randomisation the compatibility of the experimental and control groups have to be proven in this study. Therefore the experimental group is compared to the control group at the start of the study (baseline) in terms of eight variables namely, age, gender, BMI, perinatal morbidity, formal physical activity, daily physical activity, sedentary activity and total gross motor proficiency (raw and scale scores).

All three experimental subgroups/classes were first compared to the control group as one group to determine if the two groups are comparable. Then each experimental subgroup was compared separately to the control group to determine if differences existed between each experimental subgroup and the control group. The three teachers are referred to as T1, T2 and T3 as discussed in section 3.4.2. The control group is compared as a whole because, although the control group consisted of three separate grade R classes, this variable would not have an impact on the SEMOSTI Programme.

4.2.1 Comparing the Experimental Group to Control Group at Start of Study

Table 4-1 summarises the descriptive statistics for the experimental-control group comparison at the start of the study. A p-value less than 0.05 indicated a significant difference.

Table 4-1 Descriptive Statistics Comparing Experimental to Control Group

Variables	PRE-INTERVENTION		
	Experimental Group (n=35)	Control Group (n=38)	*P* value
Age (in months)			
Mean	65.3	67.4	0.069
Std Dev	5.7	4	
Gender			
Male	15	18	0.699
Female	20	20	
BMI			
Mean	16.4	16.8	0.379
Std Dev	1.6	2	
Perinatal Morbidity			
HTI	7	2	
HPI	8	1	
TIM	17	34	0.001
PIM	3	1	
Formal Physical activity			
Above median	17	22	0.425
Below median	18	16	
Daily Physical activity			
Above median	18	18	0.729
Below median	20	17	
Sedentary activity			
Above median	21	19	0.933
Below median	17	16	

*BMI refers to body mass index; *HTI refers to healthy term infants; *HPI refers to healthy preterm infants; *TIM refers to term infants with medical illnesses/sickness; *PIM refers to preterm infants with medical illnesses/sickness

The pre-intervention results summarised in Table 4-1 indicate that the experimental and control groups are matched at the start of the study in terms of all the variables except perinatal morbidity, which revealed a significant difference (p=0.001) between the two groups. The experimental group consisted of 17 infants with medical illnesses/sickness (TIM), 8 healthy preterm infants (HPI), 7 healthy term infants (HTI) and 3 preterm infants with medical illnesses/sickness (PIM) whereas the control group consisted of 34 TIM, 1 HPI, 2 HTI and 1 PIM. Statistical adjustments were made to counter for the imbalance between the two groups for perinatal morbidity.

4.2.2 Comparing the Experimental T1, T2 and T3 Subgroups to Control Group at Start of Study

Table 4-2 summarises the descriptive statistics for the experimental subgroups compared to the control group at the start of the study. A p-value less than 0.05 indicated a significant difference.

Table 4-2 Descriptive Statistics Comparing Experimental Subgroups to Control Group

Variables	PRE-INTERVENTION				
	Experimental Group			Control Group (n=38)	*P* value
	T1 (n=16)	T2 (n=11)	T3 (n=8)		
Age (in months)					
Mean	66.7	65.5	62.4	67.4	0.204
Std Dev	5.5	5.6	5.8	4	
Gender					
Male	8	4	3	18	0.87
Female	8	7	5	20	
BMI					
Mean	16.5	16.6	16.1	16.8	0.794
Std Dev	1.7	1	2.1	2	
Perinatal Morbidity					
HTI	4	2	1	2	
HPI	4	2	2	1	0.002
TIM	8	6	3	34	
PIM	0	1	2	1	
Formal Physical activity					
Above median	9	3	5	22	0.315
Below median	7	8	3	16	
Daily Physical activity					
Above median	7	6	5	18	0.837
Below median	9	5	3	20	
Sedentary activity					
Above median	6	6	7	21	0.145
Below median	10	5	1	17	

*T1 refers to teacher/class 1; *T2 refers to teacher/class 2; *T3 refers to teacher/class 3;*BMI refers to body mass index; *HTI refers to healthy term infants; *HPI refers to healthy preterm infants; *TIM refers to term infants with medical illnesses/sickness; *PIM refers to preterm infants with medical illnesses/sickness

The pre-intervention results summarised in Table 4-2 indicate that experimental subgroups and control groups are matched at the start of the study in terms of all the variables except perinatal morbidity. A significant difference (p=0.002) is indicated between the experimental T1, T2 and T3 subgroups and control group for perinatal morbidity.

Table 4-3 summarises the pre-test gross motor proficiency results for the experimental subgroups compared to the control group at the start of the study. A p-value less than 0.05 indicated a significant difference.

Table 4-3 Comparing Pre-Test Results of Experimental Subgroups to Control Group at Baseline

Variables			PRE-INTERVENTION				
			Experimental Group			Control Group (n=38)	*P* value
			T1 (n=16)	T2 (n=11)	T3 (n=8)		
Total Gross Motor Proficiency							
	Raw	Mean	92.8	82.1	90.5	94.7	0.128
		Std Dev	18.7	14.8	16.8	13.5	
	Scale	Mean	78.5	72.2	83.5	77.7	0.420
		Std Dev	15.0	15.8	17.2	13.6	
Upper-Limb Coordination							
	Raw	Mean	14.0	10.7	11.5	12.2	0.673
		Std Dev	9.1	6.3	6.8	6.5	
	Scale	Mean	14.8	13.6	14.5	13.1	0.674
		Std Dev	5.4	4.6	5.5	4.4	
Bilateral Coordination							
	Raw	Mean	16.0	13.1	17.9	16.8	0.034
		Std Dev	3.2	4.2	4.1	4.1	
	Scale	Mean	17.7	15.0	21.0	17.8	0.021
		Std Dev	3.8	3.5	4.3	4.2	
Balance							
	Raw	Mean	24.9	23.7	24.1	25.7	0.603
		Std Dev	4.7	5.4	5.4	4.2	
	Scale	Mean	13.4	12.5	13.5	13.4	0.890
		Std Dev	3.8	4.1	4.2	3.5	
Running Speed & Agility							
	Raw	Mean	24.6	21.3	22.8	26.0	0.002
		Std Dev	3.3	5.3	2.2	3.4	
	Scale	Mean	17.3	15.3	17.0	17.8	0.268
		Std Dev	2.8	5.6	3.5	3.4	
Strength							
	Raw	Mean	13.2	13.3	14.3	14.0	0.808
		Std Dev	3.8	3.8	3.5	3.4	
	Scale	Mean	15.4	15.8	17.5	15.6	0.496
		Std Dev	3.4	3.8	3.7	3.2	

T1 refers to teacher/class 1; *T2 refers to teacher/class 2; *T3 refers to teacher/class 3

The experimental subgroups and control group matched for total gross motor proficiency at the start of the study. Further investigation into the subtests of gross motor proficiency indicated three significant differences at pre-intervention. Results indicate a significant difference between the experimental and control groups for bilateral coordination raw (p=0.034) and scale (p=0.021) scores. The Dunnett's t-test indicated that experimental T2 group raw score and experimental T3 scale score differed significantly compared to the control group. Running speed and agility raw (p=0.002) score differed significantly between experimental and control groups. The Dunnett's t-test indicated that experimental T2 group raw score differed significantly compared to the control group. Consequently, in analysing the data the imbalances for pre-test scores and perinatal morbidity needed to be taken into account.

4.3 COMPARING THE POST-TEST RESULTS OF THE EXPERIMENTAL SUBGROUPS AND CONTROL GROUP

In this section, the results of the research study will be discussed in terms of how they relate to the research aim and objectives given in section 1.4. The post-test results of the experimental subgroups and control group will be compared to determine the change in gross motor proficiency over the 30-week period. It must be noted that the three experimental subgroups' post-test results did not differ significantly from each other and consequently the experimental group could have been compared to the control group as a whole. However, it was decided to compare the three experimental subgroups to the control group out of interest.

Table 4-4 summarises the post-test gross motor proficiency scores for the experimental subgroups compared to the control group at the end of the study. A p-value less than 0.05 indicated a significant difference.

Table 4-4 Comparing Post-Test Results of Experimental Subgroups to Control Group at End of Study

Variables			POST-INTERVENTION				
			Experimental Group			Control Group (n=38)	*P* value
			T1 (n=16)	T2 (n=11)	T3 (n=8)		
Total Gross Motor Proficiency							
	Raw	Mean	120.4	111.1	116.5	111.7	
		Std Dev	16.1	24.3	15.6	15.6	0.343
	Scale	Mean	88.7	83.4	90.5	79.4	
		Std Dev	14.6	21.0	15.4	13.8	0.114
Upper-Limb Coordination							
	Raw	Mean	22.3	18.3	21.8	18.1	
		Std Dev	8.4	7.6	7.8	7.1	0.222
	Scale	Mean	17.0	15.1	18.3	13.5	
		Std Dev	6.1	4.8	6.4	5.0	0.055
Bilateral Coordination							
	Raw	Mean	17.3	14.1	17.9	17.4	
		Std Dev	3.4	6.2	3.2	3.1	0.070
	Scale	Mean	16.3	14.2	18.3	16.2	
		Std Dev	4.3	5.8	2.0	3.3	0.166
Balance							
	Raw	Mean	30.1	28.5	28.1	28.6	
		Std Dev	4.2	6.1	5.7	4.6	0.722
	Scale	Mean	16.0	14.9	14.6	14.1	
		Std Dev	4.3	6.1	6.2	3.9	0.610
Running Speed & Agility							
	Raw	Mean	33.3	31.7	31.1	31.4	
		Std Dev	3.9	3.7	2.6	3.7	0.379
	Scale	Mean	22.3	21.1	21.4	20.2	
		Std Dev	3.5	4.2	3.0	3.5	0.255
Strength							
	Raw	Mean	17.6	18.5	17.6	16.2	
		Std Dev	3.1	4.0	4.0	4.0	0.266
	Scale	Mean	17.1	18.1	18.0	15.4	
		Std Dev	3.4	3.8	3.7	3.7	0.067

*T1 refers to teacher/class 1; *T2 refers to teacher/class 2; *T3 refers to teacher/class 3

The results of Table 4-4 data were analysed using the t-tests and presented as both raw and scaled scores. The results indicated no significant differences between the experimental subgroups and control group after the 30-week period of intervention. However, adjustments were made using the GLM procedure and adjusting for pre-test score and perinatal morbidity to address the initial inequalities between the experimental and control groups. The raw scores were additionally adjusted for age (in months) and gender whereas the scale scores are already adjusted for age and gender as discussed in section 3.5.1.

The Dunnett's t-test was used to determine if the three teachers (experimental group) achieved significant post-test results compared to the control group over the 30-week period. Data was adjusted for pre-test score, perinatal morbidity, age (in months) and gender to address the inequalities between the experimental and control groups.

After all regression models were completed diagnostic plots were done showing normal residual errors and no important outliers.

4.3.1 Establishing the Impact of the SEMOSTI Programme on the Gross Motor Proficiency of Four-To-Six-Year-Old Children

The research aim was to determine the impact of the SEMOSTI Programme on the gross motor proficiency of four-to-six-year-old children. The hypothesis was put forward, namely that:

H_0: The SEMOSTI Programme does not have a significant impact on the gross motor proficiency of four-to-six-year-old children.

H_1: The SEMOSTI Programme has a significant impact on the gross motor proficiency of four-to-six-year-old children.

A p-value less than 0.05 indicated a significant difference. The results are summarised in Table 4-5 to 4-8.

4.3.1.1 Total Gross Motor Proficiency (Raw) Score

The results of the comparison of total gross motor proficiency raw scores between the experimental subgroups and control group are represented in three models. The results are summarised in Table 4-5.

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Table 4-5 Multivariable Models for Total Gross Motor Proficiency Raw Score

GLM PROCEDURE MODELS FOR TOTAL GROSS MOTOR PROFICIENCY RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjustedfor pre-test score, perinatal morbidity, gender and age		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	10.4	3.3	0.003	13.2	3.5	0.000	13.6	3.6	0.000
Experimental T2	10.3	4.0	0.011	13.0	4.0	0.002	13.5	4.1	0.002
Experimental T3	8.4	4.3	0.056	12.8	4.6	0.007	14.0	5.0	0.006
Control Group	REF*			REF*			REF*		
Perinatal Morbidity HPI				-7.9	4.3	0.069	-8.0	4.3	0.071
Perinatal Morbidity HTI				-6.4	4.2	0.128	-7.2	4.2	0.093
Perinatal Morbidity PIM				-9.7	6.0	0.114	-11.5	6.2	0.069
Perinatal Morbidity TIM				REF*			REF*		
Gender Male							-3.0	2.8	0.279
Gender Female							REF*		
Age (in months)							0.2	0.3	0.524
R-Squared	0.22			0.29			0.31		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

Model 1 represents the post-test raw scores for total gross motor proficiency which was adjusted for the pre-test score at baseline. The results indicate a significant difference for experimental T1 (p=0.003) and experimental T2 (p=0.011) groups which improved more than the control group. Experimental T3 improved more than the control group (beta =8.4) but it failed to reach statistical significance.

Model 2 represents the post-test raw scores for total gross motor proficiency which was adjusted for the pre-test score and perinatal morbidity. The results changed when adjusted for perinatal morbidity. The betas (difference between means) for all three subgroups increased. T1 and T2's betas increased with approximately 26%, while T3's beta increased with 52% compared to model 1. Now all three experimental subgroups i.e. T1 (p=0.000), T2 (p=0.002) and T3 (p=0.007), indicated a significant difference by improving more than the control group. This change in betas from the unadjusted model shows that these variables adjusted for are confounders.

Model 3 represents the post-test raw scores for total gross motor proficiency, which was adjusted for the pre-test score, perinatal morbidity, gender, and age. The increase in betas is similar to model 2. All three experimental subgroups i.e. T1 (p=0.000), T2 (p=0.002) and T3 (p=0.006), indicated a significant difference by improving more than the control group. There was no significant difference between the four perinatal morbidity groups, gender or age for total gross motor proficiency. Model 2 and 3 have virtually the same betas suggesting that age and gender are not important confounders.

R-squared is a statistical measure that represents the fraction of variance explained by a model (240). The R-squared values in Table 4-5 show that in the case of model 2, 29% of the variation in the raw score is explained by these variables in the model.

The results of the Dunnett's t-tests are summarised in Table 4-6. The post-test result for total gross motor proficiency raw score of experimental T1 group is compared to control group, experimental T2 group is compared to control group and experimental T3 group is compared to control group.

Table 4-6 Dunnett's t-test Analysis for Total Gross Motor Proficiency Raw Score

DUNNETT'S t-TESTS FOR TOTAL GROSS MOTOR PROFICIENCY RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjusted for pre-test score, perinatal morbidity, age and gender		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	10.7***	2.6	18.7	10.7***	2.8	18.5	10.7***	2.7	18.6
Experimental T2 compared to control group	12.0***	2.7	21.2	12.0***	2.9	21.0	12.0***	2.9	21.1
Experimental T3 compared to control group	9.0	-1.5	19.5	9.0	-1.3	19.3	9.0	-1.4	19.3

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3.

The results indicate that both experimental T1 and T2 groups improved significantly compared to the control group regarding the gain in total gross motor proficiency over the 30-week period. Adjusting for pre-test score, perinatal morbidity, age and gender across the three models did not change the outcome. The betas for T1, T2 and T3 remained the same regardless of adjustments.

4.3.1.2 Total Gross Motor Proficiency (Scale) Score

The results of the comparison of total gross motor proficiency scale scores between the experimental subgroups and control group are represented in two models. The results are summarised in Table 4-7.

Table 4-7 Multivariable Models for Total Gross Motor Proficiency Scale Score

GLM PROCEDURE MODELS FOR TOTAL GROSS MOTOR PROFICIENCY SCALE SCORE						
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	8.7	3.1	0.006	11.2	3.3	0.001
Experimental T2	8.3	3.6	0.024	10.6	3.6	0.005
Experimental T3	6.6	4.1	0.108	11.1	4.4	0.013
Control Group	REF*			REF*		
Perinatal Morbidity HPI				-8.1	4.0	0.047
Perinatal Morbidity HTI				-4.8	3.9	0.215
Perinatal Morbidity PIM				-9.7	5.6	0.088
Perinatal Morbidity TIM				REF*		
R-Squared	0.22			0.29		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

Model 1 represents the scale scores for total gross motor proficiency, which was adjusted for the pre-test score at baseline. Both experimental T1 (p=0.006) and T2 (0.024) groups improved significantly compared to the control group. Experimental T3 (beta=6.6) failed to reach statistical significance.

Model 2 represents the scale scores for total gross motor proficiency which was adjusted for the pre-test score and perinatal morbidity. When adjusting for perinatal morbidity notable changes occurred. The betas for all three subgroups increased. T1's beta increased with 28.7%, T2's beta increased with 27.7% while T3's beta increased with 68.1% compared to the control group. After the adjustment, all three experimental groups, T1 (p=0.001), T2 (p=0.005) and T3 (p=0.013) improved significantly compared to the control group. The perinatal morbidity group indicated that HPI (p=0.047) differed significantly from TIM, HTI and PIM regarding total gross motor proficiency (scale score).

The results of the Dunnett's t-tests are summarised in Table 4-8. The post-test result for total gross motor proficiency scale score of experimental T1 group is compared to control group, experimental T2 group is compared to control group and experimental T3 group is compared to control group.

Table 4-8 Dunnett's t-test Analysis for Total Gross Motor Proficiency Scale Score

DUNNETT'S t-TESTS FOR TOTAL GROSS MOTOR PROFICIENCY SCALE SCORE						
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	8.5***	1.0	16.1	8.5***	1.2	15.9
Experimental T2 compared to control group	9.5***	0.9	18.2	9.5***	1.1	18.0
Experimental T3 compared to control group	5.3	-4.5	15.2	5.3	-4.3	15.0

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3

The results of Table 4-8 indicate that both experimental T1 and T2 groups improved significantly compared to the control group regarding the gain in total gross motor proficiency over the 30-week period regardless of adjustments. Experimental T3 (beta=5.3) group improved, but it failed to reach statistical significance. Adjusting for pre-test score and perinatal morbidity did not change the differences between the means.

4.3.1.3 Conclusion

The H_0 was rejected as the SEMOSTI Programme had a significant impact on the dependent variable, total gross motor proficiency. When interpreting the multivariable models for total gross motor proficiency raw scores, model 3 is the more reliable model which adjusts for pre-test score, perinatal morbidity, age and gender. Although model 3 indicates that T1, T2 and T3 improved significantly, the Dunnett's t-test indicate that only T1 and T2 is significant when each experimental group is compared separately to the control group.

The same trend is observed in the multivariable models for total gross motor proficiency scale scores. Model 2 seems to be more reliable than model 1. Model 2 also indicates that T1, T2 and T3 improved significantly, however the Dunnett's t-test indicated that only T1 and T2 is significant when each experimental group is compared specifically to the control group.

The Dunnett's t-test (raw and scale scores) results indicate that only experimental T1 and T2 differed significantly from the control group regardless of adjustments. Consequently, it can be concluded that two out of the three subgroups improved significantly compared to the control group thereby indicating a significant impact of the SEMOSTI Programme on total gross motor proficiency.

The results reveal differences of the impact of the SEMOSTI Programme on the total gross motor proficiency among the three teachers. Experimental T1 and T2 groups improved significantly compared to the control group, while the experimental T3 group did not improve significantly compared to the control group.

The variable perinatal morbidity (HPI) indicated significant differences for total gross motor proficiency in table 4-7 which is an interesting result, but falls outside the scope of this study and will not be discussed further.

4.3.2 Establishing the Impact of the SEMOSTI Programme on Bilateral Coordination of Four-To-Six-Year-Old Children

This research objective was to determine the impact of the SEMOSTI Programme on the motor skills subtest, bilateral coordination. The hypothesis was put forward, namely that:

H_0: The SEMOSTI Programme does not make a significant difference in the bilateral coordination of four-to-six-year-old children.

H_1: The SEMOSTI Programme makes a significant difference in the bilateral coordination of four-to-six-year-old children.

4.3.2.1 Bilateral Coordination (Raw) Score

The results of the comparison of bilateral coordination raw scores between the experimental subgroups and control group are represented in three models. The results are summarised in Table 4-9. A p-value less than 0.05 indicated a significant difference.

Table 4-9 Multivariable Models for Bilateral Coordination Raw Score

GLM PROCEDURE MODELS FOR BILATERAL COORDINATION RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjusted for pre-test score, perinatal morbidity, gender and age		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	0.3	1.0	0.756	0.9	1.0	0.352	1.1	1.0	0.295
Experimental T2	-1.2	1.1	0.273	-0.8	1.2	0.509	-0.6	1.2	0.585
Experimental T3	-0.1	1.2	0.902	0.1	1.3	0.914	0.8	1.4	0.550
Control Group	REF*			REF*			REF*		
Perinatal Morbidity HPI				-1.6	1.2	0.196	-1.7	1.2	0.155
Perinatal Morbidity HTI				-1.4	1.2	0.252	-1.5	1.2	0.211
Perinatal Morbidity PIM				0.6	1.7	0.719	0.1	1.8	0.941
Perinatal Morbidity TIM				REF*			REF*		
Gender Male							-0.5	0.8	0.538
Gender Female							REF*		
Age (in months)							0.1	0.1	0.174
R-Squared	0.25			0.28			0.30		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

The results from the multivariable models indicated no significant differences between groups. The results of Dunnett's t-test indicated that there was no significant difference between the experimental groups compared to the control group regarding the gain in bilateral coordination over the 30-week period. The beta results did not change notably across the models regardless of the adjustments. Both experimental T1 and T2 groups improved more than the control group, but it failed to reach statistical significance. Experimental T3 group presented with a non-significant lower gain in bilateral coordination than the control group.

4.3.2.2 Bilateral Coordination (Scale) Score

The results of the comparison of bilateral coordination scale scores between the experimental subgroups and control group are represented in two models. The results are summarised in Table 4-10.

Table 4-10 Multivariable Models for Bilateral Coordination Scale Score

GLM PROCEDURE MODELS FOR BILATERAL COORDINATION SCALE SCORE						
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	0.2	1.0	0.852	0.8	1.1	0.458
Experimental T2	-0.7	1.2	0.581	-0.2	1.2	0.887
Experimental T3	0.5	1.4	0.687	1.2	1.5	0.445
Control Group	REF*			REF*		
Perinatal Morbidity HPI				-1.7	1.3	0.215
Perinatal Morbidity HTI				-1.4	1.3	0.286
Perinatal Morbidity PIM				-0.6	1.9	0.753
Perinatal Morbidity TIM				REF*		
R-Squared	0.29			0.32		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

The results from the multivariable models indicated no significant differences between groups. The results of Dunnett's t-test indicated that there was no significant difference between the experimental groups compared to the control group regarding the gain in bilateral coordination over the 30-week period.

4.3.2.3 Conclusion

The H_0 is accepted as the SEMOSTI Programme did not have a significant impact on the dependent variable, bilateral coordination in the children. The multivariable models (raw and scale scores) as well as Dunnett's t-test analysis (raw and scale scores) indicated no significance.

4.3.3 Establishing the Impact of the SEMOSTI Programme on Balance of Four-To-Six-Year-Old Children

This research objective was to determine the impact of the SEMOSTI Programme on the motor skills subtest, balance. The hypothesis was put forward, namely that:

H_0: The SEMOSTI Programme does not make a significant difference in the balance of four-to-six-year-old children.

H_1: The SEMOSTI Programme makes a significant difference in the balance of four-to-six-year-old children.

4.3.3.1 Balance (Raw) Score

The results of the comparison of balance raw scores between the experimental subgroups and control group are represented in three models. The results are summarised in Table 4-11. A p-value less than 0.05 indicated a significant difference.

Table 4-11 Multivariable Models for Balance Raw Score

GLM PROCEDURE MODELS FOR BALANCE RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjustedfor pre-test score, perinatal morbidity, gender and age		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	2.0	1.2	0.089	2.3	1.3	0.077	2.4	1.3	0.059
Experimental T2	1.3	1.3	0.345	1.6	1.4	0.271	1.7	1.4	0.233
Experimental T3	0.6	1.5	0.699	1.0	1.7	0.560	1.6	1.8	0.375
Control Group	REF*			REF*			REF*		
Perinatal Morbidity HPI				0.0	1.5	0.989	-0.2	1.6	0.905
Perinatal Morbidity HTI				-1.5	1.5	0.304	-1.9	1.5	0.221
Perinatal Morbidity PIM				-1.2	2.2	0.588	-1.9	2.2	0.392
Perinatal Morbidity TIM				REF*			REF*		
Gender Male							-1.2	1.0	0.232
Gender Female							REF*		
Age (in months)							0.1	0.1	0.303
R-Squared	0.19			0.21			0.24		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

The results of the multivariable models indicated no significant differences between groups. The results of Dunnett's t-test indicated that there was no significant difference between the experimental groups compared to the control group regarding the gain in balance over the 30-week period. All three experimental subgroups improved more than the control group, but it failed to reach statistical significance.

4.3.3.2 Balance (Scale) Score

The results of the comparison of balance scale scores between the experimental subgroups and control group are represented in two models. The results are summarised in Table 4-12.

Table 4-12 Multivariable Models for Balance ScaleScore

GLM PROCEDURE MODELS FOR BALANCE SCALE SCORE						
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	1.9	1.2	0.106	2.3	1.3	0.076
Experimental T2	1.5	1.3	0.263	1.9	1.4	0.176
Experimental T3	0.5	1.5	0.746	1.1	1.7	0.505
Control Group	REF*			REF*		
Perinatal Morbidity HPI				-0.3	1.6	0.829
Perinatal Morbidity HTI				-1.9	1.5	0.216
Perinatal Morbidity PIM				-1.8	2.2	0.399
Perinatal Morbidity TIM				REF*		
R-Squared	0.12			0.15		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

The results from the multivariable models indicated no significant differences between the groups. The results of Dunnett's t-test indicated that there was no significant difference between the experimental groups compared to the control group regarding the gain in balance over the 30-week period. All three experimental subgroups improved more than the control group, but it failed to reach statistical significance.

4.3.3.3 Conclusion

The H_0 is accepted as the SEMOSTI Programme did not have a significant impact on the dependent variable, balance. All three experimental subgroups showed improvement but it failed to reach statistical significance.

4.3.4 Establishing the Impact of the SEMOSTI Programme on Running Speed and Agility of Four-To-Six-Year-Old Children

This research objective was to determine the impact of the SEMOSTI Programme on the motor skills subtest, running speed and agility. The hypothesis was put forward, namely that:

H_0: The SEMOSTI Programme does not make a significant difference in the running speed and agility of four-to-six-year-old children.

H_1: The SEMOSTI Programme makes a significant difference in the running speed and agility of four-to-six-year-old children.

4.3.4.1 Running Speed and Agility (Raw) Score

The results of the comparison of running speed and agility raw scores between the experimental subgroups and control group are represented in three models. The results are summarised in Table 4-13.

Table 4-13 Multivariable Models for Running Speed and Agility Raw Score

GLM PROCEDURE MODELS FOR RUNNING SPEED AND AGILITY RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjustedfor pre-test score, perinatal morbidity, gender and age		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	2.5	0.9	0.010	3.0	1.0	0.005	2.9	1.0	0.007
Experimental T2	2.8	1.2	0.023	3.2	1.2	0.011	3.2	1.3	0.014
Experimental T3	1.4	1.3	0.278	2.1	1.4	0.130	2.2	1.5	0.153
Control Group	REF*			REF*			REF*		
Perinatal Morbidity HPI				-2.3	1.2	0.069	-2.3	1.2	0.066
Perinatal Morbidity HTI				0.4	1.2	0.758	0.5	1.2	0.702
Perinatal Morbidity PIM				-1.0	1.7	0.587	-0.6	1.8	0.742
Perinatal Morbidity TIM				REF*			REF*		
Gender Male							0.7	0.8	0.364
Gender Female							REF*		
Age (in months)							0.0	0.1	0.816
R-Squared	0.42			0.45			0.46		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

Experimental T1 and T2 groups differed significantly from the control group for running speed and agility in models 1, 2 and 3 when adjusted for pre-test score, perinatal morbidity, gender and age. The betas for all three subgroups increased in model 2 and 3. T1's beta increased by 32%, T2's beta increased by 53.6%% while T3's beta increased by 64.3% compared to model 1.

The results of the Dunnett's t-tests are summarised in Table 4-14. The post-test result for running speed and agility raw score of experimental T1 group is compared to control group, experimental T2 group is compared to control group and experimental T3 group is compared to control group.

Table 4-14 Dunnett's t-test Analysis for Running Speed and Agility Raw Score

DUNNETT'S t-TESTS FOR RUNNING SPEED AND AGILITY RAW SCORE									
	MODEL 1 Adjusting for pre-test score			MODEL 2 Adjusting for pre-test score and perinatal morbidity			MODEL 3 Adjusting for pre-test score, perinatal morbidity, age and gender		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	3.2***	0.9	5.5	3.2***	0.9	5.4	3.2***	0.9	5.5
Experimental T2 compared to control group	5.0***	2.4	7.6	5.0***	2.4	7.6	5.0***	2.4	7.6
Experimental T3 compared to control group	2.9	-0.1	5.9	2.9	0.0	5.9	2.9	-0.1	5.9

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3.

The Dunnett's t-test indicated that both experimental T1 and T2 groups improved significantly compared to the control group regarding the gain in over the 30-week period.

4.3.4.2 Running Speed and Agility (Scale) Score

The results of the comparison of running speed and agility scale scores between the experimental subgroups and control group are represented in two models. The results are summarised in Table 4-15.

Table 4-15 Multivariable Models for Running Speed and Agility ScaleScore

GLM PROCEDURE MODELS FOR RUNNING SPEED AND AGILITY SCALE SCORE						
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	2.4	0.8	0.006	2.8	0.9	0.003
Experimental T2	2.4	1.0	0.018	2.8	1.0	0.008
Experimental T3	1.6	1.1	0.139	2.4	1.2	0.044
Control Group	REF*			REF*		
Perinatal Morbidity HPI				-2.0	1.1	0.077
Perinatal Morbidity HTI				0.1	1.1	0.948
Perinatal Morbidity PIM				-1.6	1.5	0.290
Perinatal Morbidity TIM				REF*		
R-Squared	0.36			0.39		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

Experimental T1, T2 and T3 groups improved significantly compared to the control group for running speed and agility when adjusted for pre-test score and perinatal morbidity (Model 2).

The results of the Dunnett's t-tests are summarised in Table 4-16. The post-test result for running speed and agility scale score of experimental T1 group is compared to control group, experimental T2 group is compared to control group and experimental T3 group is compared to control group.

Table 4-16 Dunnett's t-test Analysis for Running Speed and Agility Scale Score

DUNNETT'S t-TESTS FOR RUNNING SPEED AND AGILITY SCALE SCORE						
	MODEL 1 Adjusting for pre-test score			MODEL 2 Adjusting for pre-test score and perinatal morbidity		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	2.6***	0.5	4.6	2.6***	0.6	4.6
Experimental T2 compared to control group	3.4***	1.1	5.7	3.4***	1.1	5.7
Experimental T3 compared to control group	2.0	-0.7	4.6	2.0	-0.7	4.6

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3.

The Dunnett's t-test indicated that both experimental T1 and T2 groups improved significantly when compared to the control group regarding the gain in over the 30-week period. Experimental T3 group improved but it failed to reach statistical significance.

4.3.4.3 Conclusion

The H_0 is rejected as the SEMOSTI Programme had a significant impact on the dependent variable, running speed and agility, but only for experimental T1 and T2 groups. Model 3 indicated that both T1 and T2 made significant gains in raw score while model 2 indicated that all three subgroups were significant for scale scores. The results from Dunnett's t-test (raw and scale scores) indicated that both T1 and T2 gained significantly more than the control group over the 30-week period. Experimental T3 group improved, but it failed to reach statistical significance.

4.3.5 Establishing the Impact of the SEMOSTI Programme on Upper-Limb Coordination of Four-To-Six-Year-Old Children

This research objective was to determine the impact of the SEMOSTI Programme on the motor skills subtest, upper-limb coordination. The hypothesis was put forward, namely that:

H_0: The SEMOSTI Programme does not make a significant difference in the upper-limb coordination of four-to-six-year-old children.

H_1: The SEMOSTI Programme makes a significant difference in the upper-limb coordination of four-to-six-year-old children.

4.3.5.1 Upper-Limb Coordination (Raw) Score

The results of the comparison of upper-limb coordination raw scores between the experimental subgroups and control group are represented in three models. The results are summarised in Table 4-17.

Table 4-17 Multivariable Models for Upper-Limb Coordination Raw Score

GLM PROCEDURE MODELS FOR UPPER-LIMB COORDINATION RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjusted for pre-test score, perinatal morbidity, gender and age		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	2.8	1.6	0.075	3.0	1.7	0.080	3.0	1.7	0.084
Experimental T2	1.3	1.8	0.473	1.7	1.8	0.353	1.8	1.9	0.354
Experimental T3	4.2	2.0	0.043	5.5	2.2	0.015	5.7	2.4	0.019
Control Group	REF*			REF*			REF*		
Perinatal Morbidity HPI				-1.4	2.1	0.511	-1.2	2.1	0.588
Perinatal Morbidity HTI				0.2	2.0	0.905	-0.2	2.0	0.930
Perinatal Morbidity PIM				-4.9	2.9	0.097	-5.5	3.0	0.070
Perinatal Morbidity TIM				REF*			REF*		
Gender Male							-1.5	1.4	0.287
Gender Female							REF*		
Age (in months)							0.0	0.1	0.776
R-Squared	0.16			0.2			0.21		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

The results from the multivariable models indicated that only experimental T3 improved significantly compared to the control group when adjusting for pre-test score, perinatal morbidity, age and gender. However, the Dunnett's t-test analysis indicated no significant differences. All three subgroups improved, but the difference was not significant. The results of the Dunnett's t-tests are summarised in Table 4-18.

Table 4-18 Dunnett's t-test Analysis for Upper-Limb Coordination Raw Score

DUNNETT'S t-TESTS FOR UPPER LIMB COORDINATION RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjusted for pre-test score, perinatal morbidity, age and gender		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	2.4	-1.4	6.2	2.4	-1.4	6.2	2.4	-1.4	6.2
Experimental T2 compared to control group	1.6	-2.7	5.9	1.6	-2.7	5.9	1.6	-2.7	6.0
Experimental T3 compared to control group	4.3	-0.6	9.2	4.3	-0.6	9.2	4.3	-0.6	9.3

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3

4.3.5.2 Upper-Limb Coordination (Scale) Score

The results of the comparison of upper-limb scale scores between the experimental subgroups and control group are represented in two models. The results are summarised in Table 4-19.

Table 4-19 Multivariable Models for Upper-Limb Coordination ScaleScore

GLM PROCEDURE MODELS FOR UPPER-LIMB COORDINATION SCALE SCORE						
VARIABLES	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	2.2	1.1	0.062	2.3	1.2	0.070
Experimental T2	1.2	1.3	0.377	1.5	1.3	0.257
Experimental T3	3.6	1.5	0.017	4.8	1.6	0.004
Control Group	REF*			REF*		
Perinatal Morbidity HPI				-1.3	1.5	0.398
Perinatal Morbidity HTI				0.8	1.4	0.577
Perinatal Morbidity PIM				-4.0	2.1	0.063
Perinatal Morbidity TIM				REF*		
R-Squared	0.14			0.19		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

The results from the multivariable models indicated that only experimental T3 group differed significantly from the control group across all three models. However, Dunnett's t-test indicated no significant differences. All three subgroups improved but the difference was not significant. The results of the Dunnett's t-tests are summarised in Table 4-20.

Table 4-20 Dunnett's t-test Analysis for Upper-Limb Coordination Scale Score

DUNNETT'S t-TESTS FOR UPPER-LIMB COORDINATION SCALE SCORE						
	MODEL 1 Adjusting for pre-test score			MODEL 2 Adjusting for pre-test score and perinatal morbidity		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	1.9	-0.9	4.6	1.9	-0.9	4.6
Experimental T2 compared to control group	1.1	-2.1	4.2	1.1	-2.1	4.2
Experimental T3 compared to control group	3.4	-0.3	7.0	3.4	-0.2	6.9

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3.

4.3.5.3 Conclusion

The H_0 is accepted as the SEMOSTI Programme did not have a significant impact on the dependent variable, upper-limb coordination. The subgroup T3 presented with significance differences in raw and scale scores across models, however, the Dunnett's t-test analysis did not indicate any significance. Thus when all the subgroups were tested together (GLM Procedure) T3 did indicate significant differences, but when T3 was compared only to the control group (Dunnett's t-test) it did not indicate any significance.

The results revealed differences of the impact of the SEMOSTI Programme on the upper-limb coordination among the three teachers. Experimental T3 group improved significantly compared to the control group while the experimental T1 and T2 group did not improve significantly compared to the control group.

4.3.6 Establishing the Impact of the SEMOSTI Programme on Strength of Four-To-Six-Year-Old Children

This research objective was to determine the impact of the SEMOSTI Programme on the motor skills subtest, strength. The hypothesis was put forward, namely that:

H_0: The SEMOSTI Programme does not make a significant difference in the strength of four-to-six-year-old children.

H_1: The SEMOSTI Programme makes a significant difference in the strength of four-to-six-year-old children.

4.3.6.1 Strength (Raw) Score

The results of the comparison of strength raw scores between the experimental subgroups and control group are represented in three models. The results are summarised in Table 4-21.

Table 4-21 Multivariable Models for Strength Raw Score

GLM PROCEDURE MODELS FOR STRENGTH RAW SCORE									
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity			MODEL 3 Adjusted for pre-test score, perinatal morbidity, gender and age		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	1.9	1.9	0.061	3.1	1.0	0.003	3.1	1.0	0.004
Experimental T2	2.7	2.7	0.018	3.8	1.1	0.001	3.7	1.1	0.002
Experimental T3	1.3	1.3	0.295	2.7	1.3	0.042	2.6	1.4	0.069
Control Group	REF*			REF*			REF*		
Perinatal Morbidity HPI				-3.2	1.2	0.010	-3.2	1.2	0.011
Perinatal Morbidity HTI				-2.9	1.2	0.016	-2.8	1.2	0.026
Perinatal Morbidity PIM				-2.1	1.7	0.240	-1.6	1.8	0.396
Perinatal Morbidity TIM				REF*			REF*		
Gender Male							0.8	0.8	0.351
Gender Female							REF*		
Age (in months)							0.0	0.1	0.860
R-Squared	0.28			0.39			0.39		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

In the multivariable models, only experimental T2 group improved significantly compared to the control group for strength when adjusted for pre-test score. Model 2 adjusted for pre-test score as well as perinatal morbidity which resulted in all three experimental subgroups indicating significant improvements when compared to the control group. T1's beta increased by 63.2%, T2's beta increased by 40.7% and T3's beta increased by 107.7%

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when compared to model 1. Similar increases in betas were noted in model 3 compared to model 1.

Perinatal morbidity (HTI and HPI) is indicated as having a significant difference for strength in models 2 and 3; however the impact of the SEMOSTI Programme on the variables falls outside the focus of this study.

The Dunnett's t-test indicated that only experimental T2 group improved significantly compared to the control group across all three models as summarised in Table 4-22.

Table 4-22 Dunnett's t-test Analysis for Strength Raw Score

DUNNETT'S t-TESTS FOR STRENGTH RAW SCORE									
	MODEL 1 Adjusting for pre-test score			MODEL 2 Adjusting for pre-test score and perinatal morbidity			MODEL 3 Adjusting for pre-test score, perinatal morbidity, age and gender		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	2.2	-0.1	4.6	2.2	0.0	4.5	2.2	0.0	4.5
Experimental T2 compared to control group	3.1***	0.3	5.8	3.1***	0.5	5.6	3.1***	0.4	5.7
Experimental T3 compared to control group	1.2	-1.9	4.3	1.2	-1.7	4.2	1.2	-1.7	4.2

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3.

4.3.6.2 Strength (Scale) Score

The results of the comparison of strength raw scores between the experimental subgroups and control group are represented in two models. The results are summarised in Table 4-23.

Table 4-23 Multivariable Models for Strength ScaleScore

GLM PROCEDURE MODELS FOR STRENGTH SCALE SCORE						
	MODEL 1 Adjusted for pre-test score			MODEL 2 Adjusted for pre-test score and perinatal morbidity		
VARIABLES	BETA	SE	PR > |t|	BETA	SE	PR > |t|
Experimental T1	1.9	0.9	0.044	3.0	0.9	0.002
Experimental T2	2.6	1.0	0.016	3.5	1.0	0.001
Experimental T3	1.5	1.2	0.227	2.8	1.2	0.025
Control Group	REF*			REF*		
Perinatal Morbidity HPI				-3.3	1.1	0.004
Perinatal Morbidity HTI				-2.4	1.1	0.033
Perinatal Morbidity PIM				-2.1	1.6	0.201
Perinatal Morbidity TIM				REF*		
R-Squared	0.25			0.36		

*REF = Reference group; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3; HPI refers to healthy preterm infants; HTI refers to healthy term infants; PIM refers to preterm infants with medical illnesses/sickness; TIM refers to term infants with medical illnesses/sickness.

In the multivariable models experimental T1 and T2 groups indicated a significant difference from the control group for strength when adjusted for pre-test score in model 1 and T1, T2 and T3 indicated significance in model 2. Betas increased as follows, T1 increased by 57.9%, T2 increased by 34.6% and T3 increased by 86.7%. It is interesting to note that perinatal morbidity (HTI and HPI) is indicated as having a significant difference for strength, however this falls outside the scope of this study.

However, the Dunnett's t-test indicated that only experimental T2 group differed significantly compared to the control group regarding the gain in over the 30-week period as summarised in Table 4-24

Table 4-24 Dunnett's t-test Analysis for Strength Raw Score

DUNNETT'S t-TESTS FOR STRENGTH SCALE SCORE						
	MODEL 1 Adjusting for pre-test score			MODEL 2 Adjusting for pre-test score and perinatal morbidity		
	Difference between means	Simultaneous 95% Confidence Limits		Difference between means	Simultaneous 95% Confidence Limits	
Experimental T1 compared to control group	1.9	-0.3	4.1	1.9	-0.1	4.0
Experimental T2 compared to control group	2.5	-0.1	5.0	2.5***	0.1	4.8
Experimental T3 compared to control group	0.7	-2.2	3.5	0.7	-2.0	3.4

Comparisons significant at the 0.05 level are indicated by ***; T1 refers to teacher/class 1; T2 refers to teacher/class 2; T3 refers to teacher/class 3.

4.3.6.3 Conclusion

The H_0 is rejected as the SEMOSTI Programme had a significant impact on the dependent variable, strength. All groups showed significant differences from control in the regression analysis however only experimental T2 group improved significantly more than the control group for raw and scale scores when adjustment for multiple testing was done (Dunnett's t-test).

Perinatal morbidity (HTI and HPI) indicated significant differences for strength. This is an interesting result but fall outside the scope of this study and will not be discussed further.

4.4 FEEDBACK FROM THE THREE TEACHERS WHO IMPLEMENTED THE SEMOSTI PROGRAMME OVER THE 30-WEEK PERIOD

In this section, the results of the research study will be discussed in terms of the feedback that was received from the three teachers who implemented the SEMOSTI Programme over the 30-week period. This research objective was to identify the strengths and weaknesses of the SEMOSTI Programme as percieved by the three teachers.

Data from Questionnaire 4 were classified according to two groups, namely strengths and weaknesses. This was done by taking the responses to each question and categorising them as either strengths or weaknesses of the programme.

4.4.1 Feedback on weekly format of SEMOSTI Programme

All three teachers reported that the activate section of the SEMOSTI Programme had clear and precise instructions, had a good variety of different activities, and that activities increased alert levels of the children.

All three teachers reported that the just-right activity section of the SEMOSTI Programme required easily obtainable and affordable equipment and that the children were exposed to a wide variety of apparatuses. It was reported that instructions were clear and precise and that adaptation ideas were useful. All three teachers indicated that they made use of the observation suggestions and that it assisted them in identifying possible problem areas in the children.

All three teachers reported that the calm down section had clear and precise instructions, had a good selection of different activities, and that activities had a calming effect on the children.

Lastly, all three teachers reported that the activity component table contained useful information which they read on a weekly basis. They indicated that the information helped to guide them in which area of development a child might be delayed. All three teachers indicated that the table should not include more information.

No additional comments or weaknesses were reported under weekly format.

4.4.2 Feedback on monthly format of SEMOSTI Programme

All three teachers reported that the fourth week repetition format was effective in that the children still enjoyed the repeated activities and that the selected activities were adequate.

All three teachers reported that the sixteen week assessment cycle was well-timed during the school year and that the number of assessments was sufficient. However, all three teachers indicated that they needed more time to assess the developmental milestones of their respective classes. Currently, the programme scheduled one week for evaluations, but the teachers suggested that it be changed to two weeks due to the number of children they needed to evaluate.

4.4.3 Feedback on evaluation of developmental milestones of SEMOSTI Programme

All three teachers reported that the evaluation of developmental milestones section had clear and precise instructions and a user-friendly format. They reported that the weekly activity table linked effectively with the developmental milestones. However, all three teachers reported that after they had evaluated the children's developmental milestones, they did not decide on a plan-of-action for each child and they consequently did not follow through on it. Only experimental T1 teacher referred one child out of the class for professional intervention after she had compared the children's performance to the age-appropriate developmental milestones.

4.4.4 Conclusion

All three teachers perceived the SEMOSTI Programme as a positive experience and reported mostly strengths. The results, however, identified two areas of weakness. Firstly, the time scheduled for the evaluation of developmental milestones needs to be revised to accommodate larger groups. Secondly, the plan-of-action section needs to be revised to motivate teachers to apply their observations. Unfortunately, the teachers did not indicate reasons for not making use of this section in the SEMOSTI Programme.

4.5 CHAPTER SUMMARY

In this chapter, the experimental and control groups were compared at pre-intervention and post-intervention phases of the study. Groups were compared to establish if they matched as the sample was not randomised. Results indicated that the experimental and control groups differed significantly in terms of perinatal morbidity categories. Pre-test subtests in terms of bilateral coordination (raw and scale) and running speed and agility (raw) differed significantly. Consequently, in analysing the data, the imbalances for pre-test score and perinatal morbidity needed to be taken into account.

The research results for the aim and objectives were given. The post-test results of the experimental subgroups was compared to the control group to determine change in gross motor proficiency over the 30-week period. Results indicated that the SEMOSTI Programme had a significant impact on total gross motor proficiency with specific impact on running speed and agility and strength. Results from statistical analyses indicated possible differences between the three teachers who implemented the SEMOSTI Programme.

Lastly, the three teachers reported the weekly format, monthly format and evaluation of developmental milestones as strengths. Two areas of weakness were reported namely, the time scheduled for evaluation of developmental milestones and the plan-of-action section.

In Chapter 5 the results of this study will be discussed and interpreted in relation to the research aim and objectives. This chapter will also focus on conclusions and recommendations pertaining to the research question.

CHAPTER 5 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This final chapter serves to draw together the research question, the process embarked on to answer it and the results, conclusions and recommendations that emerged from the study. The following research question guided this study:

What was the impact of the SEMOSTI Programme on the gross motor proficiency of four-to-six-year-old children?

In order to answer it, firstly, a discussion and interpretation of the findings will follow and secondly, conclusions based on the statistical results will be drawn. The limitations of the study's method were discussed in chapter 3 and further limitations of the study will be elaborated on in this chapter. Contributions will be listed to demonstrate the significance of the conclusions. Lastly, the chapter closes with recommendations that emerged from this study.

5.2 DISCUSSION AND INTERPRETATION OF FINDINGS

In this section the research findings regarding the research aim and objectives will be discussed.

5.2.1 Gross Motor Proficiency

5.2.1.1 Discussion of Findings Regarding Research Aim

The impact of the SEMOSTI Programme on the gross motor proficiency of four-to-six-year- old children was the focus of this research project. The SEMOSTI Programme was designed as a possible intervention strategy to counter the increase of children presenting with motor difficulties in a public primary school. The SEMOSTI Programme is in the process of being designed and developed and this study is a pilot test to determine if it is potentially effective when implemented (see section 2.5).

The results as reported in section 4.3.1 indicated that the total gross motor proficiency, consisting of bilateral coordination, balance, running speed and agility, upper-limb coordination and strength, of the experimental group, improved significantly more than the control group. The lack of randomisation and possible influence of other variables, such as gender, age, physical activity, perinatal morbidity and BMI were taken into account through statistical adjustments. This implies that the improvement in gross motor skills of the experimental group is due to their participation in the SEMOSTI Programme.

The SEMOSTI Programme was presented by teachers in a group setting of up to 26 children per teacher without assistance (see section 3.4.2). The results implied that the use of the SEMOSTI Programme within a group setting and with teachers presenting it could produce a significant improvement in gross motor proficiency in four-to-six-year-old children. The findings support Pless's (201) argument that group motor skill intervention is effective and it further validated Sugden's (200) who suggestion that non-specialists, such as teachers, could provide effective motor development intervention.

Results indicated that one of the experimental groups (T3) did not improve significantly compared to the control group, whereas T1 and T2 showed a significant improvement in their gross motor skills compared to the control group. The Dunnett's t-test analysis consistently showed that the lowest difference between means was for T3, except for the subtest upper-limb coordination. This implies that either the implementation of the SEMOSTI Programme was different for this group or the composition of the T3 group was different compared to groups T1 and T2.

When considering the implementation of the programme, section 3.6 noted that the three teachers implemented on average the same amount of the SEMOSTI Programme. A possible explanation for the difference could be that teacher T1 and teacher T2 had previous experience with the first draft, the Grade R Programme, which aided them in delivering the SEMOSTI Programme more effectively. In addition, section 3.4.2 highlighted that teacher T3 was the youngest teacher who was newly appointed to the school. Thus, perhaps teacher T3's lack of teaching experience could have affected the implementation of the SEMOSTI Programme.

When one considers the composition of the three experimental groups, section 4.2 indicates no statistical differences concerning age, gender, perinatal morbidity, physical activity and baseline total gross motor proficiency between the subgroups. This would imply that T3's results are due to the difference in implementation described above. Alternatively, that there is a difference in the group that was not measured in this study.

Next, a discussion follows on the impact of the SEMOSTI Programme on each motor skills subtest.

5.2.1.2 Discussion of Findings for Objectives

Results of section 4.3 indicated that the running speed and agility as well as strength of the experimental group improved significantly more than those of the control group. This implies that participation in the SEMOSTI Programme caused significant improvements in running speed and agility and strength in the four-to-six-year-old children.

A possible explanation for increased strength could be that the 58 activities, specifically structured to increase arm and shoulder strength, abdominal strength and leg strength through body weight resistance, were effective (see section 2.6). The strength activities required the participants to co-contract muscle groups during various games.

A possible explanation for increased running speed and agility could be that the approach of the SEMOSTI Programme, in targeting running speed and agility, was effective. The SEMOSTI Programme consisted of 124 specifically graded activities that incorporated various movement patterns such as running, rolling, jumping, etc., which were executed under controlled conditions regarding time and duration (see section 2.6).

Assumptions regarding the activities, the implementation of the activities and the effect of execution in a group for balance, bilateral coordination and upper-limb coordination warrant further discussion. Firstly, activities need to undergo further analysis and activity strategies need to be reconsidered as results indicated that the SEMOSTI Programme activities and/or grading of the activities did not effectively stimulate balance, bilateral coordination and upper-limb coordination. In analysing these activities the performance components/skills needed to successfully execute each activity, are required to match balance, bilateral coordination and upper-limb coordination skills to ensure that the activities target the relevant skills. The degree of complexity of each activity needs to be analysed to ensure that the demands of activities are sequentially increasing throughout the programme to enhance skills. The equipment need to be reconsidered to ensure that activities target the relevant skills at the required degree of complexity. Additionally, activities need to remain fun and of interest to the children to encourage participation.

Secondly, the administration of the balance, bilateral coordination and upper-limb coordination activities by the teachers was ineffective due to a lack of implementation principles. This might imply that teachers need more support and training. Teachers should perhaps receive basic training in the sensory-motor skills that the SEMOSTI Programme targets prior to the implementation of the SEMOSTI Programme. The manual's description of each day's activity should not only include the sequenced tasks but also a description of the quality of the movements required.

Thirdly, specific to balance, the result could be due to insufficient participation of the children in the balance activities in a large group. Initially, balance requires graded weigh shifting. A rapid or too big a weight shift would initiate a protective response before balance was practiced. Next, sustained co-contraction of opposing muscle groups over a small base of support is required (2). Balance activities need to be executed in a slow and controlled manner, especially when compared to running speed and agility or upper body coordination activities (29). Within a large group the participants might rush through the activities thereby neglecting to maintain sustained co-contraction and resulting in varied protective responses. Further, participants might rely on compensatory methods such as holding on to an object or wall, which would be difficult to regulate within a larger group. This would imply that the execution of balance activities in a large group needs to be revised.

5.2.2 Strengths and Weaknesses of the SEMOSTI Programme As Perceived by the Three Teachers

The results of the feedback from the three teachers (section 4.4) indicated that they reported mostly strengths regarding the SEMOSTI Programme and manual. The teachers perceived the sequencing of the content as weekly format, monthly format, and evaluation of developmental milestones as positive. The manual was perceived as user-friendly with clear and precise instructions. The choice of activities was reported as adequate. However, the teachers identified two areas of weakness with the programme, namely the time scheduled for the evaluation of developmental milestones and the plan-of-action section.

These results imply that the time scheduled for the evaluation of developmental milestones needs to be revised. The current SEMOSTI Programme has a week for evaluations scheduled twice during the year, namely Week 16 and Week 32. However, with groups averaging 26 children, the teachers had difficulty completing the evaluations within a five-day timeframe. The teachers indicated that they need at least two weeks (10 days). However, the implications of increasing the time will result in a total of four weeks out of the 40 weeks allocated for assessing, which is roughly 10% of the duration of the SEMOSTI Programme. Other options could be to downsize the evaluation of developmental milestones to focusing only on primary gross motor skills or streamlining the evaluation process by structuring it more effectively in order to evaluate gross motor skills within a group setting.

The results also imply that the plan-of-action section needs to be reorganised. This section was intended to guide the teachers in their responses to the outcome of the evaluation of developmental milestones. Accordingly, three options were stated, namely either proceeding in presenting the SEMOSTI

Programme in the normal fashion, paying more specific attention to the problem areas identified, or referring the child for therapeutic intervention as discussed in section 2.6. Nonetheless, the teachers did not make use of this section in the SEMOSTI Programme. A possible reason could be that the teachers were aware that a research project was being conducted and therefore did not want to interfere with the study.

Overall, the evaluation of the developmental milestones-section was intended to educate and guide teachers to recognise children with definite sensory-motor delays, as literature emphasises the importance of early detection and the benefits of early therapeutic intervention (206,245). However, the findings indicated weaknesses in the design of this section of the programme. One response could be to either remove the evaluation of developmental milestones-section from the SEMOSTI Programme altogether. Alternatively, another option is to leave the section in the manual for the teachers to use at their discretion, on an ad hoc basis. The SEMOSTI Programme is primarily a strategy to stimulate underlying sensory-motor skills rather than to be used as an assessment tool. Teachers might also perceive this section as adding to their administration tasks which could decrease their compliance in the implementation of the SEMOSTI Programme.

5.3 CONCLUSIONS

5.3.1 Conclusions Regarding the Research Aim and Objectives

5.3.1.1 Research Aim

Based on the results of the study it can be concluded that the SEMOSTI Programme significantly improved the gross motor proficiency of four-to-six-year-old children in the experimental group. The SEMOSTI Programme proved promising as a possible intervention strategy in the stimulation of children's gross motor skills.

5.3.1.2 Objective 1

The first objective was to determine whether the SEMOSTI Programme improved the bilateral coordination of the four-to-six-year-old children. The results indicated that bilateral coordination did improve, but it failed to reach statistical significance. Therefore, bilateral coordination activities need to undergo further analysis to ensure that activities require the use of both sides of the body together either as simultaneous or alternating movement to be effective. The number of activities included in the programme and the degree of complexity of these activities need to be reconsidered across the 40-week period. Implementation principles for bilateral coordination activities need to be revised to ensure that teachers present activities effectively.

5.3.1.3 Objective 2

The second objective was to determine whether the SEMOSTI Programme improved the balance ability, in particular static and performance balance, of the four-to-six-year-old children. The results indicated that balance did improve, but it failed to reach statistical significance. Therefore, balance activities need to undergo further analysis to ensure that activities first require graded weight shifting followed by sustained co-contraction of opposing muscle groups over a small base of support. The number of activities included in the programme and the degree of complexity of these activities need to be reconsidered across the 40-week period. Implementation principles for balance activities within a large group need to be revised to ensure that teachers present activities effectively with more focus on the quality of movement during activities.

5.3.1.4 Objective 3

The third objective was to determine whether the SEMOSTI Programme improved the running speed and agility of the four-to-six-year-old children. From the results it can be concluded that the SEMOSTI Programme significantly improved the running speed and agility in the experimental group. The SEMOSTI Programme proved to be a promising strategy to increase running speed and agility.

5.3.1.5 Objective 4

The fourth objective was to determine whether the SEMOSTI Programme improved the upper-limb coordination of the four-to-six-year-old children. The results indicated that upper-limb coordination did improve, but it failed to reach statistical significance. Therefore, upper-limb coordination activities need to undergo further analysis to ensure that activities targets eye hand coordination and should girdle stability. The number of activities included in the programme and the degree of complexity of these activities need to be reconsidered across the 40-week period. Implementation principles for upper-limb coordination activities need to be revised to ensure that teachers present activities effectively.

5.3.1.6 Objective 5

The fifth objective was to determine whether the SEMOSTI Programme improved the strength of the four-to-six-year-old children, which included arm and shoulder strength, abdominal strength and leg strength. From the results it can be concluded that the SEMOSTI Programme significantly improved the strength in the experimental group T2. The SEMOSTI Programme proved to be a promising strategy to increase strength.

5.3.2 Conclusions Regarding the Strengths and Weaknesses of the SEMOSTI Programme As Perceived by the Three Teachers

From the results it can be concluded that the three teachers perceived the SEMOSTI Programme as user-friendly and effective. However, the evaluation of developmental milestones-section needs to be revised or removed from the SEMOSTI Programme.

5.4 LIMITATIONS OF STUDY

5.4.1 Limitations of the SEMOSTI Programme as intervention

The SEMOSTI Programme is a newly designed stimulation programme that falls within Step 2 of Fraser and Galinsky's five-step model of intervention research (57). The programme has not yet undergone efficacy or effectiveness studies and consequently, has not been proven to be valid or reliable as discussed in section 2.5.

A limitation of this programme is that the developed manual has not been reviewed by professionals or scholars in the field with expertise related to the target problem, population, or setting. The researcher moved from design to pilot testing the programme material, without first having it reviewed as discussed in section 2.5. Thus, the programme theory and content on which the SEMOSTI Programme is based could be found wanting.

The SEMOSTI Programme addresses various sensory-motor areas in the development of four-to-six-year-old children through age-appropriate activities (see section 2.5). However, this study only tested one component, namely gross motor proficiency, of the SEMOSTI Programme. The results of this study are thus limited to gross motor proficiency and cannot be generalised to the other components of the programme (i.e. sensory processing; perceptual processing; neuromusculoskeletal aspects; and motor skills). This process is acceptable according to Fraser and Galinsky (57) who state that intervention programmes are refined through a series of studies where results suggest the strengthening or elimination of some intervention components.

The SEMOSTI Programme is designed as a 40-week programme that runs weekly for the whole school year, excluding school holidays (section 2.5). Unfortunately, the researcher could only research the first 30 weeks of the programme, essentially disregarding the last 10 weeks of the programme as explained in section 3.6.1. This was done to fit the research project into the school calendar and allow for as much as possible time for participants to participate in the SEMOSTI Programme.

5.4.2 Limitations of the Procedure

5.4.2.1 Implementation fidelity

The fidelity measures to ensure uniform implementation appear to have been insufficient. The results of the study indicated overall significant differences in gross motor proficiency between the three teachers who implemented the SEMOSTI Programme. One of the experimental groups (T3) did not improve significantly, whereas T1 and T2 showed a significant improvement in their gross motor skills compared to the control group. The results imply that the teacher is a possible variable affecting the outcomes of the SEMOSTI Programme. The differences between the teachers, in terms of age, years of teaching experience, exposure to the SEMOSTI Programme and personality could have impacted on how they implemented the SEMOSTI Programme which would have affected the results.

The fidelity measures for implementation were discussed in section 3.6.1. These included the following: an hour training in the implementation of the SEMOSTI Programme at the start of the study; fully manualizing the SEMOSTI Programme; checking in with teachers every 10 weeks over the 30-week period of the study for support; and having all three teachers follow a 30-week schedule based on a calendar to ensure that they presented the same activities on the same days. Ongoing support and more training of teachers, as well as more detailed documentation of how the different teachers presented the SEMOSTI Programme should have been implemented.

5.4.2.2 Missing data and attrition

An initial sample of 100 participants was included in this study. However the sample size reduced due to participants being absent on the days of testing, questionnaires not being returned, questionnaires being incomplete with missing data and participants moving away from the respective schools (section 3.4.2). At the end of the study, only 73 participants' data were statistically analysed and reported. The 73 participants had complete sets of data and did not need adjustment for missing data. Therefore, the return rate can be considered as adequate and missing data and attrition is not considered as a limitation of this study.

5.4.2.3 Potential confounding variables

Variables other than the SEMOSTI Programme may account for the reported results due to a lack of randomisation. However, all known potential confounding variables, such as age, gender, perinatal morbidity, physical activity, BMI, pre-tests scores at baseline, and different teachers implementing the programme, were addressed through adjustments in statistical analysis.

5.4.2.4 Appropriateness of analysis

Appropriate analysis is necessary to come to a conclusion that the SEMOSTI Programme caused the reported outcomes. The researcher attempted to compensate for initial differences found between experimental and control groups by conducting the GLM Procedure and Dunnett's t-tests, using as covariates the participants' demographic characteristics and baseline outcome measures for which there were differences. Therefore, the data analysis methods used was appropriate to answer the study questions and is not considered as a limitation of this study.

5.4.2.5 External validity of study

The external validity of this study is low. External validity (61) refers to the degree to which the conclusions of this study can be generalised to other four-to-six-year old children in other schools and at other times. The sample size used in this study was too small to be representative of the population, and consequently, the results cannot be generalised to the larger population.

5.4.2.6 Internal validity of study

The internal validity of this study could be called into question due to a lack of randomisation in the sampling. Internal validity (61) refers specifically to whether an experimental intervention makes a difference or not, and whether there is sufficient evidence to support the resulting claims.

A pretest-posttest control group design was utilised to ensure internal validity of this study as discussed in section 3.4.1 (238). Normal maturation among four-to-six-year old children was controlled by this design as maturation would have manifested equally in both experimental and control groups (238). Covariates at the start and end of the study were adjusted for through statistical analysis (240). Covariates such as age, gender, physical activity, BMI, perinatal morbidity and pre-test scores at baseline were taken into account. Both the control and experimental groups were tested within the same time frame (at the start and end of a 30-week period) within similar school settings and using the same measuring instruments. The researcher is therefore of the opinion that, through the controls of this design, the study has internal validity.

5.5 SUMMARY OF CONTRIBUTIONS

The purpose of most/all research is to inform action (61). This study was intended to research the impact of the SEMOSTI Programme on the gross motor proficiency of four-to-six-year-old children. No previous research to date has been done on the SEMOSTI Programme.

This study should be viewed as the first pilot study (57) and possibly as part of a series of pilot studies leading to larger studies of efficacy and effectiveness of the SEMOSTI Programme. The SEMOSTI Programme is in the process of evaluation to determine if it is an effective strategy to enhance motor proficiency in grade R. The findings from this study indicated that the SEMOSTI Programme proved effective over a 30-week period in improving the gross motor proficiency of Afrikaans, middle-class, four-to-six-year-old children at one school.

The approach of active participation in a variety of purposeful, age-appropriate play activities that promote sensory-motor experiences and stimulate basic foundation motor skills by providing opportunities for practice proved effective in improving gross motor proficiency. The SEMOSTI Programme is guided by 10 principles based on neuro-maturation theories, dynamic systems theory, sensory integration, motor learning theory, neuronal group selection theory as well as guidelines for physical activity and the role of teachers in motor development (see section 2.5).

The SEMOSTI Programme was proven to be promising, but the validity and reliability of the programme was not investigated or proven. The practical implications of this study were that it provided information regarding the impact of the SEMOSTI Programme on gross motor proficiency and feedback from the three teachers who implemented the programme over the 30-week period. The data can now be used to revise the content and reconceptualise the programme as part of the design and development process.

5.6 RECOMMENDATIONS

This final section of the research report presents recommendations that should be considered, firstly in policy and practice relating to early childhood care and education programmes, and secondly with respect to future research and development work that may be carried out in this regard.

5.6.1 Policy and Practice

It is recommended that the policies found in South Africa, regarding the lifestyle threat to the health of South African children and youth, should be revised. The rapid increase in overweight and obesity, in combination with low levels of physical activity is a real threat. Additionally, the need for proper training and developmentally appropriate tools for grade R teachers were highlighted in section 2.4. Teachers need to be adequately trained to effectively teach grade R learners (i.e. language, maths and life skills) and enhance development in terms of gross and fine motor skills, visual perception and auditory perception. Appropriate tools such as fine motor stimulation programmes, gross motor stimulation programmes and visual and auditory perception programmes, which targets the developmental period of four-to-six-years are necessary.

Section 2.2.1 reported that the “Draft School Sport Policy for Public Schools in South Africa” (82) has nearly been finalised (2010) and training of teachers in physical education has commenced. Physical education in schools is now a compulsory component of the Life Orientation Learning Area in the national curriculum statement, which is a step in the right direction (82). However, it is recommended that the policy should also include age-appropriate school-based intervention for especially the foundation phase (grade R to 3) with specific programmes that focus on improved fundamental motor skills with a play-development approach. As extant research indicated that preschool children develop mostly through play activities (183). Additionally, research has indicated that children should acquire the fundamental motor skills, as it has been proven that if they fail to learn the foundation motor skills; they tend to have decreased participation in games and sport and experience failure in general motor tasks (141, 162).

5.6.2 Further Research and Development Work

The results of this research identified the strengths and weaknesses of the SEMOSTI Programme as perceived by the three teachers (section 4.4). It is recommended that the SEMOSTI Programme be revised to resolve the weaknesses in order to refine and improve the effectiveness of the stimulation programme.

The SEMOSTI Programme proved effective when implemented by the grade R teachers. Section 2.6.1 discussed the role of teachers and parents in implementing interventions to address motor development in children (199,200). Parents did not play any role in the SEMOSTI Programme, except providing demographic information for the study. Thus, the possible role of parents in the SEMOSTI Programme for transfer of knowledge and skills to the home environment should be considered for further development.

Section 2.6 highlighted Fraser and Galinsky's recommendation that the completed draft of the manual be reviewed by experts (57). It is recommended that the SEMOSTI Programme manual should be reviewed by professionals with expertise in child development, development of sensory-motor skills and four-to-six-year-old children (grade R).

Although results indicated that the SEMOSTI Programme had a significant impact on the gross motor proficiency of four-to-six-year-old children, it should be supported by replication of research to gather more data. It is strongly suggested that randomisation should be used whenever feasible in future research (57).

The SEMOSTI Programme was designed to achieve three targets: to improve motor skills in four-to-six-year-old children; increase physical activity; and guide teachers to identify children with possible developmental delays. This research study only investigated the impact of the SEMOSTI Programme on the gross motor skills. It is recommended that the impact of the SEMOSTI Programme on the physical activity of four-to-six-year-old children be investigated in the future.

Specific feedback was received from the three teachers who implemented the SEMOSTI Programme over the 30-week period regarding evaluation of developmental milestones of the SEMOSTI Programme (section 4.4.3). It is recommended that the manual be revised accordingly and that the target of the effectiveness in guiding teachers in early detection be investigated.

It is recommended that a standardised measuring instrument, such as the Physical Activity Questionnaire for Preschool-Age Children (Pre-PAQ®) should be used to determine physical activity in future studies. At the time of this project no standardised questionnaire was available (section 2.7). However, since the study commenced, Dwyer, Higgs, Hardy and Bauer (236) developed the Pre-PAQ® as an epidemiological tool to measure physical activity in young children. Initial validity studies have shown that the Pre-PAQ is valid for measuring active behaviours, but does not measure sedentary behaviour accurately (236). Dwyer et al. is currently in the process of optimizing the tool (236).

Finally, it is recommended that the impact of conditions such as asthma, diabetes, etc. on gross motor proficiency be further researched within the South African context. This would enable the identification of additional risk or mediator factors related to gross motor proficiency to guide future intervention. Section 2.2 reviewed current trends possibly influencing the motor skills development in children which revealed unexplored and under-researched areas. No current data regarding the prevalence of diabetes type 1 and type 2, low muscle tone and developmental coordination disorder (DCD) among South African children could be found. Data were insufficient to determine a correlation between gross motor proficiency with diabetes type 1.

5.7 CHAPTER SUMMARY

It is evident from the research findings and conclusions that the SEMOSTI Programme had a significant and positive impact on the gross motor proficiency of the four-to-six-year-old children compared to the control group. Through daily 45-minute active participation in a variety of purposeful age-appropriate play activities which promotes sensory-motor experiences and stimulates basic foundation motor skills by providing opportunities for practice over a 30-week period, the experimental group significantly improved total gross motor proficiency, specifically running speed and agility, and strength. While changes in balance, upper-limb coordination and bilateral coordination failed to reach statistical significance.

The evidence indicated that the use of the SEMOSTI Programme in grade R as a strategy to improve gross motor proficiency is promising. After further reseach and revision, the implementation of the SEMOSTI Programme should be considered in other grade R classes.

The information obtained in this study is intended to give ideas, guide future research and raise awareness of current social trends impacting on children on a motor development level and the importance of effective strategies to combat these influences.

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