Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth

By

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DECLARATION:

In accordance with Rule G5.6.3, I hereby declare that the above-mentioned dissertation is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: 

DATE: 11 November 2018

5.6.3 A treatise/dissertation/thesis must be accompanied by a written declaration on the part of the candidate to the effect that it is his/her own work and that it has not previously been submitted for assessment to another University or for another qualification. However, material from publications by the candidate may be embodied in a treatise/dissertation/thesis.
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ABSTRACT

Context: Globally, the association between physical fitness, motor proficiency and scholastic achievement has been well researched. However, information concerning the effectiveness of integrated movement programmes in children from various socio-economic disparities, is less well studied. A lack of studies exists on the relationship between perceptual-motor development and scholastic performance in literacy and numeracy in children from low-middle income countries such as in sub-Saharan Africa. Thus, the need exists for educational movement programme implementation in developing countries based on studies of good methodological design, to allow early prevention, identification and rectification of apparent motor deficits in young children.

Purpose (Aim): To investigate effects of an integrated movement programme in the classroom setting on motor proficiency, visual-motor integration and scholastic achievement of grade one learners between the ages of six- to nine-years-old in quintile five primary schools in Port Elizabeth.

Methods: A quasi-experimental research design was used to evaluate the selected dependent variables at baseline assessment on 45 grade one learners from an experimental-and control group in quintile five schools in Port Elizabeth. There were two intervention periods that consisted of a pre-existing classroom-based integrated movement programme (NeuroNet) administered by an internationally accredited teacher to the experimental group. Each intervention period coincided with school terms three and four in 2017 and were a minimum of four weeks long. Pre-test and post-test assessments for all three dependent variables were done at the beginning and end of each term respectively. The learners participated in the integrated movement programme five days per week for 20-minute duration in the classroom. The main two standardised, reliable and valid test batteries used to measure motor proficiency and visual-motor integration were the Bruininks-Oseretsky Test of Motor Proficiency Brief Form (BOT-2 Brief Form) and the Beery-Buktenica Developmental Test of Visual-Motor Integration Full Form sixth edition (Beery VMI). The Beery VMI contained two sub-tests the Beery VMI Visual Perception Test (VMI-VP), and the Beery VMI Motor Coordination Test (VMI-MC), which measured the participants' visual...
perception and motor coordination. Scholastic achievement was measured using four domains of the participants’ school reports: numeracy, reading, writing and total scholastic achievement scores. Purposive sampling was used to obtain participants from quintile five primary schools whose principals voluntarily provided consent to undertake the study. Data was collected by trained research assistants and the sole researcher. The Statistica for Windows (StatSoft Incorporated; 2014) software package was used for data analysis. Descriptive data analysis included the means (M) and standard deviations (SD) as measures of central tendency and distribution. Independent t-tests determined between-group differences and the level of significance was set at p<0.05. The magnitude (effect size) of pre-post-intervention differences for both groups was calculated for all variables as Cohen’s d statistic. Subsequent interpretation categories were d<0.20 (insignificant effect), 0.20≤d<0.50 (small effect), 0.50≤d<0.80 (medium effect) and d≥0.80 (large effect) (Gravetter & Wallnau, 2009).

Results: The experimental group had statistically significant (p<0.05) higher initial mean values for motor proficiency, visual perception, the reading, writing and total scholastic achievement domains. Motor proficiency showed a mean increase of 10.62±13.97 (24% improvement) in the experimental group compared to a mean increase of 9.63±13.26 (8% improvement) in the control group. A significant final mean between-group difference in motor proficiency was found post-intervention (Diff=16.70, t(43)=3.70, p=0.001; Cohen’s d=1.11: large effect size). Visual-motor integration showed a mean decrease of 5.38±14.34 in the experimental group and a decrease of 8.88±15.39 in the control group. No apparent between-group significant difference occurred for visual-motor integration. Visual perception scores indicated a mean increase of 11.82±18.81 in the experimental group and a mean increase of 15.71±30.03 in the control group. A statistically significant mean between-group difference in visual perception post-intervention was seen (Diff=26.40, t(43)=3.95, p<0.0005; Cohen’s d=1.18: large effect size). Motor coordination showed a mean increase of 20.00±18.45 in the experimental group and decrease of 1.50±23.74 in the control group over the intervention period (Diff=21.50, t(43)=3.36, p=0.002; Cohen’s d=1.00: large effect size). There was a significant between-group mean motor
coordination difference post intervention (Diff=19.59, t(43)=2.96, p=0.005; Cohen’s d=0.88: large effect size). The experimental group showed significantly higher mean reading scores pre- 5.67±0.80 and post-intervention 5.43±0.93 compared to the control group pre- 4.13±0.74 and post-intervention 4.63±0.88. Significant between-group differences in reading scores pre- (Diff=1.54, t(43)=6.73, p<0.0005; Cohen’s d=2.01: large effect size) and post-intervention (Diff=0.80, t(43)=2.99, p=0.005; Cohen’s d=0.89: large effect size) were also evident. The experimental group also showed significantly higher mean writing scores pre- 5.62±0.74 and post-intervention 5.05±0.86 compared to the control group pre- 3.83±0.96 and post-intervention 4.21±1.28. A significant between-group difference in writing scores pre- intervention (Diff=1.79, t(43)=6.90, p<0.0005; Cohen’s d=2.06: large effect size) was evident. Total scholastic achievement scores showed an initial significant difference between the experimental- and control group (Diff=1.26, t(43)=6.42, p<0.0005; Cohen’s d=1.92: large effect size). Positive practical significance |r|≥0.300 at (p<0.05) was found between visual-motor integration and reading |r|=0.350; visual perception and writing |r|=0.336; motor coordination and writing |r|=0.318; visual-motor integration and total scholastic achievement |r|=0.330 in the experimental group. In the control group negative practical significance |r|≥0.300 at (p<0.05) was found between visual perception and reading |r|=-0.304, whereas positive practical significance was found between visual perception and writing |r|=0.319; motor coordination and writing |r|=0.340; motor coordination and numeracy |r|=0.378; and motor coordination and total scholastic achievement |r|=0.378 at (p<0.05).

**Conclusion:** The integrated movement programme had significantly positive effects on motor proficiency, visual perception and motor coordination. Motor proficiency had no significant correlation to scholastic achievement domains post-intervention, whereas visual-motor integration significantly correlated to reading and total scholastic achievement; visual perception correlated significantly to writing and negatively to reading; and motor coordination correlated significantly to writing, numeracy and total scholastic achievement. Future longitudinal research incorporating a larger range and scope is needed to fully evaluate the effectiveness of integrated movement
programmes on motor proficiency, visual-motor integration and scholastic achievement.

**Keywords**

Motor proficiency, visual-motor integration, scholastic achievement, integrated movement programme, pre-adolescent, perceptual-motor development, motor deficits
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LIST OF ACRONYMS

Acad: Scholastic achievement

Beery VMI: Beery-Buktenica Developmental Test of Visual-Motor Integration Full Form

BOT-2 Brief Form: Bruininks-Oseretsky Test of Motor Proficiency Brief Form

Chi²: Chi-square value

Cohen’s d: Effect size used to indicate the standardised difference between two means

d.f.: Degrees of freedom

Diff: Difference between pre- and post-test

Mean: Average

MP: Motor Proficiency

n: Total number of participants

N: Numeracy

p: p-value

Pre1: Pre-test 1

Post1: Post-test 1

Pre2: Pre-test 2

Post2: Post-test 2

R: Reading
t: t-Test result
T: Total Scholastic Achievement
VMI-VP: Beery VMI Visual Perception Test
VMI-MC: Beery VMI Motor Coordination Test
W: Writing
±S.D.: ±Standard deviation
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1. CHAPTER ONE: PROBLEM FORMULATION

1.1 INTRODUCTION

Physical activity and the beneficial outcomes on child development has been a main focus for research for an extended period and is a well-known field of enquiry (Malina, Bouchard, & Bar-Or, 2004:3-14; Rowland, 2005:474-478). In previous times it was believed that a healthy body created a healthy mind as developed by Socrates approximately 400 BC (Van Dalen & Bennett, 1971:61). This notion has been known by physical educators for decades as indicated by traditional goals and objectives of physical education systems (Kirkendall, 1986:49). As early as 1893, Thomas Wood, theorised that physical education contributed to more than just the physical dimension of the child, but also facilitated significant development in the emotional, social and intellectual well-being and therefore necessitated a whole-child approach to learning (Tomporowski, Lambourne, & Okumura, 2011:S4).

Development of Kinderkinetics is an increasingly growing field of study and aims to improve the total wellness of children between birth to the age of twelve (Pienaar, 2009:49-67; Riethmuller, Jones & Okely, 2009:783; Tomporowski et al., 2011:S4). This improvement is achieved through stimulation, rectification and the promotion of age-specific visual-motor integrated movements and physical activities to develop gross-motor, fine-motor and perceptual-motor skills, which is the main purpose of kinematic programmes (Pienaar, Barhorst, & Twisk, 2014:371-372). Various international studies have been conducted in developed countries on the relationships between visual-motor integration, perceptual-motor development, motor proficiency and literacy in writing, reading and mathematics. These studies indicate positive relationships between the aforementioned variables (Solan & Mozlin, 1986:28-35; Parush, Sharoni, Katz, & Hahn-Markowitz, 2000:216-231; Sortor & Kulp, 2003:213-215,758-763).
Although extensive research has been done, studies concerning the design and implementation of integrated movement-based programmes on primary school children in the classroom setting, has been sparsely documented (Malina et al., 2004:3-14; Rowland, 2005:474-478). According to Riethmuller and co-authors (2009:788) there is a limited quantity and quality of scientific evidence on motor programme interventions and associated known effects on cognitive development in children. More scientific evidence is needed on the potential neuro-plastic effects of physical activity in the development of children’s cognitive abilities (Sibley & Etnier, 2003:243-256). Barkley (2012:1-7) stated that executive functioning is the foundation for adequate cognitive functioning and develops rapidly during the early ages of six- to nine-years-old with a slower progression into adolescence. According to Barkley (2012:1-7) executive functioning is the ability to get tasks done through acquiring a set of mental skills such as attention and time management. Therefore, it is important to develop these skills as early and extensively as possible to ensure future success in mental development. This highlights that executive functioning is a key component of integrated movement interventions.

As children develop they go through fundamental developmental stages as described by Balyi and Hamilton (2004:1-8), indicating adaptation and the acquisition of optimal trainability. Developmental models theorise that mental-cognitive, physical and emotional aspects all develop parallel through the ages of before five- to twenty-two years (Balyi & Hamilton, 2004:1-8; Edwards, 2010:250-257; Hurd & Anderson, 2010:42-43). Balyi and Hamilton’s (2004:1-8) model states that males from the ages of six- to nine-years-old and females from the ages of six- to eight-years-old are placed in stage one, which is the fundamental stage. This initial stage includes the improvement of overall motor movement skills with cognitive and social development occurring simultaneously. Movement skills include locomotor, manipulative and stability components, which ties in with what the proposed study tried to achieve (Manna, 2014:48-50). The study aimed to do this through identifying relationships between motor proficiency, visual-motor integration and scholastic achievement within the specific age range of six- to nine-year-old children. This study measured cognitive
development using the body as an instrument during the performance of an integrated movement programme and in so doing, assessed global processing involved in intelligence and ultimately scholastic achievement (Tomporowski et al., 2011:S5).

Correlation studies have been done on large samples of adolescents and children, and these studies indicate that there are moderate to strong positive correlations between taking part in physical education, the quantity of activity and scholastic achievement, as well as behaviour in the school environment (Carlson, Fulton, & Lee, 2008:721-727; Roberts, Freed, & McCarthy, 2010:711-718). Therefore, if in accordance to research evidence, positive associations exist between physical activity and cognitive development, then integrated movement programmes should provide a sustainable intervention to promote health associated with physical activity and exercise in all socio-economic classes from developing to developed countries globally (Tomporowski et al., 2011:S4).

There is a lack of studies determining the relationships between visual-motor integration, perceptual-motor development and motor proficiency and literacy in writing, reading and mathematics in developing countries (Lotz, Loxton, & Naidoo, 2005:63-67; Pienaar et al., 2014:371). South Africa is seen as a developing and middle-income country with high socioeconomic discrepancies and is therefore exposed to different child development strategies compared to developed countries (Zere & McIntyre, 2003:1-10). Children living in impoverished areas, as evident in most parts of South Africa, are exposed to a number of environmental, task and individual constraints which may interfere with cognitive and regulatory learning processes such as working memory and attention (Haywood & Getchell, 2014:255-271; Glady, French & Thibaut, 2017:1-13). Research suggests the aforementioned constraints cause development of deficits in analogical reasoning, attention regulation, and poor academic outcomes (Glady et al., 2017:1-13).
According to Huston (1994) deficits in perceptual-motor development occur due to limited access of learning materials and unconducive home environments. This is supported by Parush and colleagues (2000:216-231) who state that the absence of a stimulating home environment, inadequate schooling, specific patterns of learning practices with varying expectations of children and attitudes towards learning, different conceptualisations of appropriate behaviours, and skills encouraged for child development, are all influences that can hinder perceptual-motor and cognitive development. In 2014 the average score for a Grade 1 learner in South Africa was 63.2% in Home Language and 68.4% in Mathematics, of all the learners who completed an antinuclear antibody test (Department of Basic Education, 2016:26). Furthermore, approximately only 75.3% attained a score above 50% in Home Language and 80.9% in Mathematics (Department of Basic Education, 2016:26).

Literature therefore indicates the need for pedagogical intervention programme implementation to allow the rectification of these apparent deficits in young children through the means of quantitative studies of good methodological design. By using assessment batteries that are culture-fair, reliable and valid, and movement-related, scholastic difficulties can be identified at an early age and larger-scaled country-wide interventions could be initiated to improve overall early childhood development in South Africa.

The aim of this study was to investigate an educationally designed integrated movement programme in terms of the effects it had on movement skills (motor proficiency and visual-motor perception) and scholastic achievement in primary school children of a higher socioeconomic status (quintile five) in Port Elizabeth in the Eastern Cape province of South Africa. This research aimed to add to the needed research on the effectiveness of Kinderkinetics on motor and cognitive development in young school-going children in a developing country. The research question, aim, objectives, significance of the study, methodology, results, discussions, conclusions, limitations and recommendations for future research are discussed in the sections to follow.
1.2 RESEARCH QUESTION, AIM & OBJECTIVES

1.2.1 Research Question

The research question allows the establishment of the main question for the study and outlines the main research objectives. It allows the development of subsequent questions pertaining to the main aim of the research to allow an extensive valid study (Jonker & Pennink, 2010:14).

What are the effects of an integrated movement programme as an in-classroom intervention on the motor proficiency, visual-motor integration and scholastic achievement of grade one learners between the ages of six- to nine-years-old in selected quintile five primary schools in Port Elizabeth?

1.2.2 Research Aim

The research aim is a broad statement about the study being conducted and includes the population, intervention, comparison, outcomes and study design of the research. In essence, it is the overarching purpose of the study being conducted (Buckler & Walliman, 2016:63).

For this study, the aim was to investigate the effects of an integrated movement programme on the motor proficiency, visual-motor integration and scholastic achievement of grade one learners between the ages of six- to nine-years-old in two quintile five primary schools in Port Elizabeth.
1.2.3 Research Objectives

According to Buckler and Walliman (2016:63) research objectives are specific statements of intent that are addressed directly. Objectives are goals that are specific, measurable, attainable and reachable within a certain time constraint that are directly linked to the main conclusions of the review and indicates how research can build on the current state of the scientific community’s knowledge (Thomas & Hodges, 2010:40-53).

To address the research question, the objectives pertaining to 45 learners who were six-to-nine-years-old from two quintile five primary schools in Port Elizabeth using an experimental and control (comparison) group were:

1.2.3.1 To assess the effects of the integrated movement programme on motor proficiency using the Bruininks-Oseretsky test of motor proficiency Brief Form (BOT2-Brief Form).

1.2.3.2 To assess the effects of an integrated movement programme on visual-motor performance by using the Beery-Buktenica developmental test of visual-motor integration full form (Beery VMI) and sub-tests for visual perception and motor coordination.

1.2.3.3 To assess the effects of the integrated movement programme on scholastic achievement measured through the results each learner obtained in numeracy, reading, writing and total scholastic achievement before and after two intervention periods.

1.2.3.4. To determine the relationship between motor proficiency, visual-motor integration and scholastic achievement post-intervention.
1.3 SIGNIFICANCE OF STUDY

This explains the importance of the research within the scientific community by having an inductive or deductive perspective. Inductive states the importance from particular to general and deductive states the importance from general to particular (Paler-Calmorin & Calmorin, 2007:37).

For this study, a deductive perspective was used. The significance was to add to the pedagogical body of knowledge in South Africa and internationally, on the efficacy of an integrated movement intervention targeting the development of motor skills, visual-perception and scholastic achievement in a classroom setting in young children, specifically in Port Elizabeth. The combined movement and cognitive approach was to inform the practices of physical education teachers at primary schools in the creation of such integrated movement programmes, specifically catering for children during their fundamental development years. This approach was also used to challenge teachers to seek ways to screen for, identify and modify such programmes for developmental and motor disorders in children. Early identification of children with motor deficiencies is of importance to allow for remedial intervention and to ensure the creation and implementation of optimal learning programmes.
1.4 TERMINOLOGY

1.4.1 Motor proficiency - the ability to complete complex and fine-motor skills through the development of complex integrated movement patterns and motor control. Motor proficiency can be used as an index of a child’s motor development (Bruininks & Bruininks, 2010:12; Venetsanou & Kambas, 2016:14-20).

1.4.2 Visual-motor integration – the degree to which visual perception and finger-hand movements are well coordinated (Beery & Beery, 2010:13).

1.4.3 Scholastic achievement – refers to a learner’s success in meeting short- or long-term goals in education according to certain criteria developed by government (Chakrabarti, 2008:77-78).

1.4.4 Integrated movement programme – Learning through movement via research-based learning readiness programmes designed to develop fluency in skills such as reading, maths and handwriting. This is achieved by combining rhythmic exercise with drills in academic skills (NeuroNet learning, 2016). NeuroNet learning is an example of such an intervention strategy.

1.4.5 Quintile five school – Schools in South Africa are categorised into five quintiles for the allocation of funding by the Department Of Basic Education. Quintile one caters for the poorest twenty percent of schools and quintile five caters for the least poor twenty percent of learners in a province. The provincial department of education collects annual data from each school to rank schools per socioeconomic status. The poverty scores are determined by the catchment area of the school and community sources of poverty such as household income, dependency ratio/unemployment rate and level of education of the community (Department of Basic Education: Pretoria, 2004).
1.5 SUMMARY

Kinderkinetics is an increasingly growing field of study that has been previously explored with relations to developmental processes but still lacks empirical research on the effects of certain intervention programmes on motor proficiency, visual-motor integration and the effects thereof on cognitive abilities (Malina et al., 2004:3-14; Rowland, 2005:474-478; Tomporowski et al., 2011:S4). Literature resources indicate that deficits in any motor development field, including visual perception, visual-motor integration and motor proficiency jeopardises a child’s school readiness and therefore can reflect negatively on their academic performance (Pienaar et al., 2014:371; Pienaar & Kemp, 2014:167-169). South Africa has a lack of research in this field of study and therefore more studies exploring the different variables that can affect a child’s motoric and cognitive development need to be done in order to further understand the multifactorial relationship of cognition and development. Extensive research will also allow for appropriate intervention implementation to prevent higher frequencies of developmental deficits in South Africa (Pienaar & Kemp, 2014:167-169; Pienaar et al., 2014:371). This study therefore aimed to allow elaboration on these concepts and relationships.
2. CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

The effects of physical activity on health, growth, cognitive development as well as scholastic achievement of children are often underrated. Over the last couple of decades there has been a transformation from an old-school to modernised world where children, normally having played outside and being stimulated by the outdoors, have become increasingly sedentary and tend to favour technology as sole stimuli (Rasberry, Lee, Robin, Laris, Russell, Coyle & Nihiser, 2011:S10-S20). A minimum of 60 minutes physical activity per day is needed in order to remain healthy, as proposed by the World Health Organisation (WHO) in 2010. This amount is very rarely accomplished by children in our modernised environments, having a negative impact on both their physical and cognitive health and development (Stein, Auerswald & Ebersbach, 2017:1). When children participate in regular physical activity from a young age, they develop confidence and a positive attitude towards movement activities which can potentially benefit their cognition (Nalder & Northcote, 2015:2).

Development of the study of Kinderkinetics is continuously growing and aims to improve the total wellness of children between birth to the age of twelve (Riethmuller et al., 2009:783; Tomporowski et al., 2011:S4). Basic fundamental motor skills are the building blocks to more advanced movement and allow for a foundation to optimally function in different environments on a social, cognitive and motor level to add to overall growth and development (Pienaar, Van Rensburg & Smit, 2011:113). According to research, there is a consistent positive relationship between physical activity and the development of children’s motor skills at ages below ten-years-old due to the wide interplay between the brain and the body (Fredericks, Kokot, & Krog, 2006:29-42; Riethmuller et al., 2009:783; Magistro, Bardaglio & Rabaglietti, 2015:149-163). International research generally indicates adequate development in motor integration skills has positive effects on scholastic achievement (Erwin, Fedewa & Ahn, 2013:120-121; Magistro et al., 2015:149-163; Nalder & Northcote, 2015:9-10;
Reeves, Miller & Chavez, 2016:117-120). The investigation of integrated movement programme effects on scholastic performance in grade one learners has not been done sufficiently in South Africa as evidence in literature is scarce.

This study investigated the potential effects that motor proficiency, visual-motor integration, visual-perception and motor coordination had on scholastic achievement in grade one learners and the literature to accompany the rationale for the study is provided in the sections to follow.

### 2.2 BRAIN-BODY INTERFACE

The role of movement in a child’s mental and physical development has been of interest to parents, academics and researchers for over a century. Western civilisation has made the assumption that physical and mental competence are linked, as reviews of developmental specialists’ recommendations indicate that children who are raised in stimulating environments and who have liberal opportunities to explore movements are able to better adapt to changing environments (Tomporowski, McCullick, Pendleton & Pesce, 2015:47).

Physical activity is a subset of exercise, which involves structured, planned, purposeful and repetitive movements with the aim of improving or maintaining one or more of the components of physical fitness (Garber, Blissmer, Deschenes, Franklin, Lamonte, Nieman & Swain, 2011:1334-1359). Recent research gives light onto how exercise may promote improvements in mental function, specifically the processes called executive functions, which play an important role in adaptive behaviours, intellectual functioning, and academic success in children (Riley, Lubans, Holmes & Morgan, 2014:2; Tomporowski et al., 2015:47; Nalder & Northcote, 2015:2). Executive functioning is the term referring to all the complex cognitive processes needed to perform goal-orientated tasks, and includes being able to delay or inhibit a response,
developing a sequence of actions, using working memory to hold a mental representation of the task, problem solve, incorporate relevant feedback and selectively make revisions to original plans, retrieve ideas from long-term memory to develop and implement appropriate strategies, and are under voluntary and conscious control (Piek, Dyck, Nieman, Anderson, Hay, Smith, McCoy & Hallmayer, 2004:1064; Ackerman, Friedman-Krauss & Service, 2017:1-2). Intervention studies indicate that both acute (singular) and chronic (repeated) physical exercise has positive effects on cognitive functions of children and adults (Tomporowski et al., 2015:47-54; Stein et al., 2017:1-11).

There is a close neuronal interrelation in the brain between the areas of motor function (the cerebellum) and cognitive control (the prefrontal cortex), and this becomes apparent when investigating disorders such as Developmental Coordination Disorder (Leonard & Hill, 2015:1; Stein et al., 2017:1-11). This disorder is diagnosed when a child has difficulties in acquiring and executing motor skills, adversely negatively impacting activities of daily living and scholastic achievement and is often followed by developmental problems in attention, speech, language and behaviours (American Psychiatric Association, 2016; Đorđić, Tubić & Jakšić, 2016:4). Traditionally executive functioning was related to prefrontal cortex functioning, but recent neuropsychological evidence indicates there is a structural and functional connection between the prefrontal cortex and the cerebellum used in motor skills. Thus, suggesting cognition, perception, motor behaviour and emotions are in close relationship (Diamond, 2007:152-159; Leonard & Hill, 2015:2; Đorđić et al., 2016:3-7).

The theoretical reasoning behind this correlation between movement and improved cognition can be explained by two mechanisms. Firstly, the physiological mechanism where physical activity elicits physiological changes, such as increasing cerebral blood flow and stimulating the release of neurotransmitters, chemical substances that act as neural messengers and positively affect cognitive functions (Südhof & Starke, 2007:2-5; Stein et al., 2017:1-11). Secondly, the developmental mechanism where skills and
relations learned through sensorimotor experiences in infants can be transferred to cognitive problem solving, forming the basis for further cognitive development through continual acquisition and execution of new and more complex motor movements, stimulating higher cognitive functioning as a child develops (Piaget, 1972:157-164; Südhof & Starke, 2007:209-220; Stein et al., 2017:1-11). This therefore leads to the suggestion that if a child’s perceptual systems such as is evident in motor proficiency and visual-motor integration are not adequately developed, a deficit in their cognitive abilities and therefore their scholastic success will be present.

2.3 INFLUENCIAL DEVELOPMENT PERIODS

Gallahue, Ozmun and Goodway (2012:48) define motor development as changes in movement behaviour over time from learning how to control and become competent in movements through observation of changes in form and product or performance of a movement. These researchers continue to explain motor development to be viewed as stage-like and phase-like with observable sequential movements being categorised into: 1) stabilising movement tasks which are both non-locomotor and non-manipulative in nature, requiring balance and posture, 2) locomotor movement tasks which involve changing location of the body relative to a fixed point, and 3) manipulative movement tasks involving gross-motor manipulation such as exerting or receiving force from an object, and fine-motor manipulation. Fine-motor manipulation requires intricate movements of the hand and wrist muscles, or combinations of the aforementioned skills displayed in activities such as skipping over a rope or playing sports. Patterns of development are complex since learnt patterns are the product of different biological, cognitive and socio-affective processes (Santrock, Woloshyn, Gallagher, Petta & Marini, 2010:34).

Children and adolescents go through different phases of motor development comprised of certain sequential stages where critical movement skills and competencies have to be learned (Jedynak, 2009:64-76; Gallahue et al., 2012:49).
The researchers continue to state that if children experience difficulties in the acquisition of the fundamental movement skills or the refinement of competencies during the aforementioned phases, deficits or slowing in motor and cognitive development could occur. During the first eight years of a child’s life, basic or fundamental movement pattern acquisition depends on the rate of neuromuscular maturation, residual effect of movement experiences and current experiences, and the child’s growth and maturation status (Đorđić et al., 2016:3-7). As children develop, maturation of brain and nerve structures allows for positive effects on power and balance through improving speed and efficiency of information processing and therefore motor competence is largely influenced by continual learning and exercising once these fundamental patterns have been established (Đorđić et al., 2016:3-7). During infancy and adolescence brain growth occurs at a rapid rate due to a growth spurt occurrence in the cerebellum, causing significant changes in coordination, postural control, balance, muscular tone, and cognitive functioning (Piaget, 1972:157-164; Malina et al., 2004; Südhof & Starke, 2007:209-220; Đorđić et al., 2016:3-7; Stein et al., 2017:1-11). Developmental disorders are often linked and precede each other with regards to motor, cognitive and other deficits, reiterating the affiliation of physical and intellectual development (Harris, Mickelson & Zwicker, 2015:659-664; Đorđić et al., 2016:3-7). An example of this is Developmental Coordination Disorder involving deficits in motor coordination, followed by developmental disorders associated with attention, speech or language and behaviour (Đorđić et al., 2016:3-7).

The first phase of development is the reflexive movement phase comprised of the primitive and postural reflex stages and occurs from when a child is in utero to one year old where involuntary movements occur (Santrock et al., 2010:35; Gallahue et al., 2012:52). The researchers identified the second phase as the rudimentary movement phase consisting of the reflex inhibition stage from birth to one year old and the pre-control stage from ages one to two years, involving the first signs of voluntary movements needed for survival. The third phase in the fundamental movement phase with the initial stage occurring from two to three years old, the emerging elementary stage occurring at three to five years old, and the proficient stage occurring at ages
five to seven (Santrock et al., 2010:35; Gallahue et al., 2012:52). The third phase involves the exploration and experimentation of movement potential for children as they are most susceptible to change and neuromotor development during these stages (Santrock et al., 2010:35; Gallahue et al., 2012:52). The last phase is the specialised movement phase consisting of the transitional stage occurring at ages seven to 10, the application stage from 11 to 13 years old, and the lifelong utilisation stage from the age of 14 upwards. Movement becomes a tool for complex actions involved in activities of daily living, recreation and sport during this last phase of movement (Gallahue et al., 2012:54).

For this study, the focus was on the proficiency acquired in the fundamental movement phase and in the transitional stage of the specialised movement phase. The proficient stage requires the maturation of movements to be mechanically efficient, coordinated and well controlled. The focus in this stage is continuous improvement of product components of motor skills through practice, encouragement and instruction. If an environment that encourages learning and growth is not created within this stage, application and development in the specialised movement phase will be inhibited and difficulties will be created in developing proficiency in fundamental movement skills (Stodden, Goodway, Stephen, Roberton, Rudisill, Garcia & Garcia, 2008:291-295; Gallahue et al., 2012:54).

The specialised movement phase is where the refinement, combination and elaboration of stability, locomotor and manipulative skills occur to enable an individual to deal with more complex movement situations (Gallahue et al., 2012:54). The theoretical underpinnings provided by Gallahue et al. (2012:54) state that the patterns of movements learnt and naturally created during fundamental movements are the same patterns used for sport-specific skills but have been updated to accommodate performance of movement in more complex situations. Learning of sport specific skills can be made easier by mastering fundamental movement patterns, therefore children are encouraged to participate in as wide of a variety of activities as possible during the
transitional stage to enable them to have an adequate base to develop and specialise from later on in life (Balyi & Hamilton, 2004:2-4; Gallahue et al., 2012:54-55). This enables a child to develop their perceptual-motor skills as a whole, including motor proficiency and visual perception.

This study therefore investigated the proficient development of children’s visual-motor skills from the ages of six-to-nine during the critical periods mentioned above and the interaction with cognitive abilities. In so doing, the link between the field of Kinderkinetics and Neuroscience were explored.

2.4 LEARNING READINESS

Learning readiness is the basis of the developmental and cognitive growth processes in children, and refers to the ability of a child to learn easily and sufficiently without emotional complexity (Sharma, 2006:29-31; Pekdogan & Akgul, 2016:114-152) Many researchers use this term congruently with the term “school readiness” (Rimm-Kaufman, 2004:1-4; Ladd, 2009:1; Britto & Limlingan, 2012:1-6). Conceptually readiness involves equipping learners with skills that enable them to attain the necessary physical and mental capacity to provide the background needed in order for children to learn (Rao, 2002:68). Learning readiness is considered the foundation of equity and quality education, allowing children to engage in lifelong learning and to reach their full developmental potential (Britto & Limlingan, 2012:3). Multiple factors, such as family, teachers, environments and school facilities affect a child’s adaptation to learning and therefore learning readiness (Pekdogan & Akgul, 2016:114-152).

Pekdogan and Akgul (2016:114-152) state that children who have not previously attended schooling-like institutions such as pre-primary have greater difficulty developing this readiness, negatively influencing their scholastic achievement. This is supported by Britto and Limlingan (2012:3-4) who state that sufficient learning
readiness has a positive effect on academic outcomes in primary and secondary school, as well as social and behavioural aptitudes later in life. Success in school is determined by characteristics such as abilities in literacy, numeracy, working with other children, ability to follow instructions and engaging in learning activities. This relates to motor development, cognition, general knowledge, social and emotional development and all other domains of development and learning (Britto & Limlingan, 2012:4).

In South Africa, there is a significant number of children who have not reached sufficient levels of learning readiness before entering grade one (Bruwer, Hartell & Steyn, 2014:18-35). This inadequacy is due to poor learning environments at home or limited access to proper preschool programmes and is currently very evident in disadvantaged communities. The lack of quality learning opportunity has a significant negative impact on a child’s development and future school career due to not being able to meet the correct criteria and qualifying to be ready for formal learning (Green, Parker, Deacon & Hall, 2011:109-122). This research propagates the need for appropriate intervention programmes to enable the youth of South Africa to become more equipped for constructive learning and development. The exploration of this field further highlights the need for learner readiness in all children to optimise development in all domains, especially in motor- and cognitive abilities, to ensure scholastic success.

2.5 MOTOR PROFICIENCY AND VISUAL PERCEPTION

Humans are forever evolving through adaptation of abilities and skills to improve quality of life in a meaningful and satisfying manner. Skills related to development such as motor proficiency, visual perception, and fundamental movement skills add to the consort of functional capacity characteristics of people and allow humans to exist and thrive in different environments (Rietmuller, 2011:11-51; Gallahue et al., 2012:46-55). The process of human development involves two driving factors, namely
biological and environmental factors, which allow children to develop in shape, size, maturity, motor proficiency and physical ability (Gallahue et al., 2012: 46-55). The ability to adequately perform motor skills in different environmental conditions depend on a variety of factors and plays a large role in participation of sport and physical activity (Wrotniak, Epstein, Dorn, Jones & Kondilis, 2006:34-44; Barnett, van Beurden, Morgan, Brooks & Beard, 2010:162-163; Kokštejn, Musálek & Tufano, 2017:1-10). These factors include the physical characteristics of the learner such as strength, balance, body size and brain development (Newell, 1986:347-353; Leonard & Hill, 2015:1-14; Ackerman et al., 2017:1-15). The characteristics that influence motor proficiency and visual perception are discussed in the sections to follow.

2.5.1 Motor Proficiency

Motor proficiency is the ability to complete complex and fine-motor skills through the acquisition of complex integrated movement patterns (Bruininks & Bruininks, 2010:12; Venetsanou & Kambas, 2016:14-20). Motor proficiency aids development of motor control and can be used as an index of a child’s motor development (Bruininks & Bruininks, 2010:12; Venetsanou & Kambas, 2016:14-20). Such motor proficiency skills are observed and assessed in movement that require running speed and agility, balance, bilateral coordination, strength, upper-limb coordination, response speed, visual-motor control, upper-limb speed and dexterity (Tecklin, 2008:75-89).

A major biological factor influencing motor proficiency is gender. A large volume of studies have examined the effects of gender differences in young children and show great controversy among researchers (Barnett et al., 2010:162-170; Venetsanou & Kambas, 2016:14-20; Kokštejn et al., 2017:1-10). These studies include the examination of total battery scores using the Denver II developmental screening test for cognitive and behavioural problems in preschool children (Durmazlar, Ozturk, Ural, Karaagaoglu & Anlar, 1998:411-416), composite scores using the Test of Gross-Motor Development-2 to measure motor abilities (Goodway & Robinson, 2010:17-24), or
individual item scores using the Movement Assessment Battery for Children (Waelvelde, Peersman, Lenoir, Smits Engelsman & Henderson, 2008:30-38). Gender differences in motor performances for the abovementioned test batteries were seen as insignificant. In contrast, other studies reported significant differences to favour girls for skills like hopping, skipping, threading beads, drawing trails, and flexibility when assessment of total and composite scores for test batteries concerned with fine and gross-motor skills were used (Sigmundsson & Rostoft, 2003:451-459). In comparison, Venetsanou and Kambas (2016:14-20) found that boys performed better at skills such as catching, throwing, striking, standing long jump, kicking and short dashes. From the reported studies, sufficient evidence exists on the discrepancy in research between girl’s and boy’s performance skills in terms of motor proficiency. Numerous factors potentially play a role in childhood development and thus contribute to the discrepancies found in research. To note but a few, everyone is different in terms of childhood upbringing where motor proficiency might have been taught by various role models, where some children may not have had access to pre-school education, genetic make-up variations and physiological development discrepancies (Department of Basic Education, 2013:16-24; Pienaar et al., 2014:371; Venetsanou & Kambas, 2016:14-20).

As children develop chronologically, which is the number of years a person has been alive, they generally mature in motor ability and learn to master more complex tasks with the aid of cognitive maturation (Piek, 2006:156-165; Kokštejn et al., 2017:1-10). There is no fixed rate of child development with age as all children grow differently. This variability could have adverse effects on motor, cognitive and perceptual development and thus lead to the concept of stages of readiness instead of specific chronological ages of readiness, which ties in with the literature stated in the above section on influential stages of development (Piek, 2006:156-165; Gallahue et al., 2012:54).
Genetic endowment and maturation also contribute as biological influences on motor development. Genetics and hereditary traits are primary determinants of physical development in terms of height, weight and relative lengths and breadths which have adverse effects on motor development and proficiency through specific genetic codes (Haywood, Roberton, & Getchell, 2012:216). If genetic discrepancies occur prenatally, deficits in motor development and therefore functional ability may occur (Haywood et al., 2012:216). Hormonal maturation is important for controlling physiological processes such as metabolism for growth, maturation, adaptation and learning, and these changes generally occur after puberty from the ages of nine to fourteen in both genders. Typically, this does not affect performance of very young learners as used in this study, because girls and boys have similar physiological makeups until puberty, therefore normative data is not gender specific (Rogol, Clark, & Roemmich, 2000:521S-527S; Malina et al., 2004:13-18).

The main environmental influences on motor proficiency include physical-, social- and psychological factors such as nourishment, health, safety, opportunity, practice, encouragement and instruction (Gordon & Browne, 2010:373), as well as recreational activities and physical education in schools (Horn, 2015:29-32). According to research done by Venetsanou and Kambas (2010:319-327) family features such as socioeconomic status, mother’s educational level and number of siblings can affect children’s motor competence. The aforementioned researchers also highlighted the influence of social cultural context in which children are raised. Socio-cultural contexts place specific demands on children’s motor behaviour which tend to favour motor proficiency in the performance of some skills and may lead to impairment in others (Venetsanou & Kambas, 2010:319-327; Morley, Till, Ogilvie & Turner, 2015:150-156).
2.5.2 Visual Perception

Visual perception is the process of extraction and organisation of visual input from the environment (Pienaar et al., 2014:371). This is done using cognitively developed skills to integrate visual information with sensory modalities, past experiences and higher cognitive functions (Pienaar et al., 2014:371). This differs from visual acuity, as acuity refers to how clearly a person can see through their visual systems ability to resolve detail (Levenson & Kozarsky, 2011:563-564). A child can therefore have clear 20/20 vision and still experience difficulties with perceptual processing which can have adverse effects on the ability to perform certain motor tasks and scholastic performances (Schwartz, 2004; Van Dantzig, Pecher, Zeelenberg & Barsalou, 2008:579-590). Optimal development of visual perception skills is important for activities such as reading, writing, putting together puzzles, drawing and any activity that requires fine or gross-motor skills (Schwartz, 2004; Dhingra, Manhas & Kohli, 2010:143-147).

In order to develop adequate visual perception, the following prerequisite skills are necessary:

- **Sensory processing** – Appropriate registration, interpretation and response to environmental stimuli and to one’s own body (Schwartz, 2004).
- **Visual attention** – The ability to select and ignore relevant and irrelevant information respectively from a visual environment through specific cognitive operations (McMains & Kastner, 2009:4296-4302).
- **Visual discrimination** – The ability to differentiate between objects based on colour, shape, size, etc. (Schwartz, 2004).
- **Visual memory** – The ability to remember characteristics of objects when the visual stimulus is no longer present (Brady, Konkle & Alvarez, 2012:1-5).
- **Visual-spatial relationships** – The understanding of the relationships between objects in different environments (Schwartz, 2004).
- **Visual sequential-memory** – The ability to remember the correct order of words, letters, or stories as seen originally (Nicholson, 2017).
• Visual figure ground – The ability to identify a specific object within a busy background (Schwartz, 2004).
• Visual form constancy – The ability to cognitively manipulate forms and visualise the specific outcomes (Le Roux, 2017).
• Visual closure – The ability to identify an object or shape when part of the object or shape is missing (Schwartz, 2004).

Development of the abovementioned skills allows a child to comprehend the task at hand (Nicholson, 2017). If a child has difficulty controlling and moving their eye muscles, the child will have difficulty processing visual information cognitively and will perform poorly at tasks involving visual perception during fine and gross-motor skills (Nicholson, 2017). This delayed processing can have negative effects on a child’s scholastic performance, attention and concentration, self-regulation, behaviour, frustration levels, organisation skills and they may tend to avoid tasks involving visual perception completely (Schwartz, 2004; Van Dantzig et al., 2008:579-590; Dhingra et al., 2010:143-147).

2.5.3 Visual-motor Integration

Visual-motor integration is the combination of visual perception and motor proficiency to allow efficient hand-eye coordination to complete certain tasks (Capellini, Giaconi & Germano, 2017:258-259). Motor proficiency and visual perception are therefore important for proper child development and play a large role in the efficiency of everyday actions (Coetzee & Du Plessis, 2013:37-40; Pienaar & Kemp, 2014:167-168). Studies indicate that handwriting as a perceptual-motor skill acquired through practice and develops quickly from the ages of six to seven years. This skill tends to plateau towards the end of the first grade and beginning of the second grade (Julius, Meir, Shechter-Nissim & Adi-Japha, 2016:265-272).
Difficulties in the acquisition and use of speaking, reading, writing, listening, reasoning- or mathematical abilities are classified as the umbrella term, specific learning disabilities (Mona, Dhadwad, Yeradkar, Adhikari & Setia, 2015:492). The three types of specific learning disabilities are: dyslexia, dysgraphia and dyscalculia (Mona et al., 2015:492). Dyslexia is a term used to classify children that have difficulty in reading, interpreting words, letters and symbols, but does not affect their general intelligence; dysgraphia is when a child has difficulty with handwriting; and dyscalculia is when a child has difficulties with mathematical sequences (Wood, 2011:23-25). Children affected by these and similar learning disorders develop deficits in visual, auditory, kinaesthetic or tactile perception, and motor abilities compromising activities of daily living (Mona et al., 2015:492). Visual-cognitive deficits, fine-motor difficulties or poor integration lead to visual-motor disorders in children (Mona et al., 2015:493).

2.5.4 Development of Visual-motor Integration

According to Gordon and Browne (2010:373) motor skills form the foundation for motor proficiency and overall movement from early childhood, and can be termed fundamental movement skills. The fundamental movement skills aid children with the control of their bodies in space and to manipulate their environment, therefore are the building blocks to the advancement of movement skills and the development of sport specific skills (Goodway, Crowe, & Ward, 2003:298-314). If these skills are not adequately developed, the incompetency may jeopardise future participation in physical activity and may lead to motor deficiencies as well as learning deficits (Goodway et al., 2003:298-314; Riethmuller et al., 2009:e782-e783; Pienaar et al., 2014:370-371).

Motor development can only be accelerated as quickly and as extensively as possible through the skills having been motivated and challenged by the physical environment a child is exposed to (Horn, 2015:31). However, due to manifold constraints such as changes in post-modern life, many families are unable to supply a conducive learning
and physically stimulating environment for the competent development of motor proficiency and visual perception (Horn, 2015:31). Specifically in South Africa, these constraints include many children belonging to orphanages due to inadequate care by guardians, increasing HIV/AIDS statuses, unsafe environments for children to play outside in parks due to increasing crime rates, guardians not being able to cognitively stimulate children due to long working hours or working multiple jobs (Van Heerden, De Kock, Larsen, Knopjes, Singh & Franzsen, 2011:38).

In 1967 two psychologists, Paul Fitts and Michael Posner, created a three-stage model of motor skill learning which was based on observations that various cognitive- and perceptual-motor processes are involved at different stages in the learning process. The Fitts-Posner model has become widely accepted and is used in multiple disciplines concerning motor skills and development (Edwards, 2010:250-257). Edwards’ model (2010:250-257) in conjunction with the adaptation of training and optimal trainability model displayed in figure 1 and Gallahue’s hourglass model in figure 2 (Salehi, Sheikh & Talebrokni, 2017:217-233), explain the variety of changes children go through and the stages of development that occur (Balyi & Hamilton, 2004; Hurd & Anderson, 2010:42-43).
**Figure 1:** Adaptation of training and optimal trainability (Balyi & Hamilton, 2004)

**Figure 2:** Gallahue’s Hourglass Model (Salehi, Sheikh & Talebrokni, 2017:217-233)
These phase-stage theories suggest that universal age periods exist in which children display certain characteristic behaviours which last for arbitrary periods of time (Hurd & Anderson, 2010:43). The phasic model has led to the development of intervention programmes as these stages act as criterion measures for child skill development. The intervention programmes can therefore allow adequate development of motor skills that lay down the foundation for motor learning, which aid in scholastic achievement (Riethmuller et al., 2009:e783-e790; Beery & Beery, 2010:10-17; Pienaar et al., 2014:370-376).

2.6 MOTOR DEVELOPMENT AND COGNITIVE ABILITIES

According to Hurd and Anderson (2010:41) there are three learning domains which are highly integrated. These are the cognitive-, psychomotor- and affective domains. The psychomotor domain consists of psychomotor abilities which are the physical skills and movement characteristics of a child; the cognitive domain incorporates the relation of intellectual knowledge to a movement skill being learned; and the affective domain is comprised of the child’s values, attitudes, social skills and interactions in all physical activities (Seidel, Perencevich, & Kett, 2007:8-10; Hurd & Anderson, 2010:41-42). Sensation, perception and cognition are therefore affected by one another which explains the effect of sufficient motor skill development on improved scholastic performance (Beery & Beery, 2010:11). Research done by Abdelkarim and co-researchers (2017:325-330) supports this notion by identifying a significant correlation between total motor and total cognitive learning abilities, concluding that encouraging physical fitness development at primary school age could augment motor and cognitive learning abilities related to scholastic achievement in school.

Beery and Beery (2010:10-13) firstly explain that visual development involves higher brain activation for pattern or size discrimination and interpretation of visual stimuli (intermediate step between simple visual sensation and cognition). As children’s nervous systems mature they can learn part-whole integration and remember light and
dark boundaries for certain basic shapes. Secondly, motor development occurs from a generalised to specific viewpoint through increased differentiation and integration of movements via the action of the cerebellum of the brain to control specific muscles (Beery & Beery, 2010:10-13). Lastly, the sensory and expressive modalities are interconnected and coordinated in humans and the first sensory-response integrated system to develop may be the visual-motor system. Therefore, a child could have well developed singular visual and motor skills but be unable to integrate the systems, leading to being unable to be visually aware of location and direction through voluntary eye movement. Thus, affecting the ability to respond accordingly with appropriate limb movement to, for example, copy forms with a pencil (Beery & Beery, 2010:13). The researchers found that a child without adequately integrated perceptual systems, but with the necessary motor development of these systems, showed adverse effects in scholastic performance as observed in the inability to draw, copy or interpret shapes correctly (Beery & Beery, 2010:13).

These claims are supported by research done by Pienaar and colleagues (2014:376) who concluded that there is a strong relationship between scholastic performance and visual-motor integration, visual perception, hand control and motor proficiency. Pienaar et al. (2014:376) found a relationship between a clustered academic performance score, visual-motor integration and visual perception and therefore indicated that all these skills and motor proficiency are closely related to basic academic skills in a child’s grade one year of schooling. Tomporowski and colleagues (2011:S5) also suggest that executive skills acquired by children through playground activities may cross-over to scholastic performances and conditions in the real world involving behaviour inhibition, working memory and strategy formation.

The aforementioned research clearly outlines the need for coordinated movement in children at primary school level to allow propagated development in cognition and potentially improved scholastic achievement. This has led to the development of
integrated movement programmes needing to be implemented at the critical stages of children’s maturation.

2.7 IMPORTANCE OF INTEGRATED MOVEMENT PROGRAMME INTERVENTIONS

Development is achieved through stimulation, rectification and the promotion of age-specific visual-motor integrated movements and physical activity to achieve the main purpose of movement-related programmes. This aim is to develop gross-motor, fine-motor and perceptual-motor skills (Pienaar, Barhorst, & Twisk, 2014:371-372). As previously explained motor proficiency, visual-motor integration, visual perception and hand control have important impacts on scholastic achievement of young learners (Pienaar et al., 2014:370; Abdelkarim et al., 2017:325-330). This notion has led to the development of test batteries such as the BOT-2 Brief Form and Beery VMI used in this study which, through early screening, allow the identification of children who need special assistance in certain learning domains. Such children include individuals with learning disabilities or deficits (characteristic of children from constraint lower socio-economic status areas), development coordination disorders (dyspraxia, clumsy child syndrome, developmental apraxia, minimal brain dysfunction or perceptual-motor dysfunction), mild to moderate mental retardation, or pervasive developmental disorders (Autism, Rett’s syndrome, Asperger’s disease, childhood disintegrative disorder) (Bruininks & Bruininks, 2010:30-31; Beery & Beery, 2010:17).

The identification of such disabilities through movement test batteries has led to the development of movement interventions, which have been shown to have positive influences on children’s fundamental movement skills (Tomporowski et al., 2011:S5; Yang, Lin & Hsu, 2016:2318-2321). Interventions aim to rectify apparent learning deficits in children and indorse appropriate development through clinical exploration, intervention planning and implementation (NeuroNet learning, 2016). Such interventions achieve this through structured movement-based programmes
performed by children to facilitate quicker and easier learning, improved sport performance, increased focus and organisation, overcoming learning disabilities, improving self-esteem and confidence (Peel, Prinsloo, Evans, Nell & Basson, 2016:12-18).

Research indicates that movement-based intervention programmes implemented either at school, or in the home setting can improve scholastic achievement through being granted access to cognitive and motor integration (Resaland, Aadland, Fusche, Aadland, Skrede, Stavnsbo, Suominen, et al., 2016:322-328). The brain benefits from any type of physical activity due to the increased blood flow it receives allowing the availability of oxygen and glucose to enhance its function, therefore further stipulating the need for increased movement in children (Reeves et al., 2016:117). Research done by Summerford (2001:7) further concludes that physical activity increases the neural connections of the brain in the hippocampus, which is centrally involved in learning and memory. Although positive findings have been associated with physical activity and learning capabilities, it should be noted that the content of specific movement programmes are of importance. Regular physical education programmes showed no significant improvement in scholastic performance and motor proficiency, while significant improvements in both were found in children engaged in sensory and perceptual motor programmes as seen in a study done by Longhurst, Coetsee & Bressan (2004:79-88).

Therefore, with cross-curricular integration of movement-based activity programmes that focus on visual-motor integration and motor proficiency, the development of the vestibular-, proprioceptive-, tactile-, visual- and auditory systems can be achieved. This will enable children to learn scholastic work, sit still, pay attention, complete tasks and learn appropriate social behaviours within their correct developmental periods (Fredericks et al., 2006: 32; Nalder & Northcote, 2015:2).
2.8 DEVELOPMENT OF INTEGRATED MOVEMENT PROGRAMMES INTERNATIONALLY

Internationally recognised movement programmes such as Brain Gym International and the NeuroNet Learning programme have sprouted interests into the field of cognitive development through increased physical activity (Peel, Prinsloo, Evans, Nell & Basson, 2016; Rowe, 2017). Various studies in developed countries indicate a positive relationship between visual-motor integration, perceptual-motor development and motor proficiency and literacy in writing, reading and mathematics (Solan & Mozlin, 1986:28-35; Parush, Sharoni, Katz, & Hahn-Markowitz, 2000:216-231; Sortor & Kulp, 2003:213-215,758-763; Reeves, Miller & Chavez, 2016:118). Although previous research indicates positive influences, physical education classes and recess sessions are being shortened or cut from public school curriculums to supposedly achieve higher academic standards (Reeves et al., 2016:117). This therefore propagates the need for more substantial research on integrated movement programmes to find a sustainable way of keeping physical activity integrated into school curriculums through other means.

2.8.1 NeuroNet Learning Programme

The NeuroNet classroom enrichment programme was devised in the U.S. by an audiologist named Nancy Rowe whose focus was on helping children improve their coordination of motor and cognitive skills in educational environments that encouraged self-evaluation and trial and error problem solving. NeuroNet is based on 30 years of neuroscience research and relies on three concepts on neuroscience: memory, attention, and automaticity (Costello, 2012). This programme involves learning through and with movement and has specific timing elements to the movements incorporated in the programme. Neuroscience indicates that more neural networks are stimulated and strengthened with correct rhythm and timing of movement patterns, and this therefore represents learning (Australian Early Childhood Mental Health Initiative, 2014). NeuroNet has been shown to benefit all types of learners no matter if an auditory, kinesthetic or visual learner (NeuroNet learning, 2016).
According to Elizabeth Rhodes, Head of Foundation Phase at Clarendon Primary in Port Elizabeth, one of the main challenges teachers face in a classroom setting is that children do not have the necessary skills to filter and use input and disregard unnecessary stimuli (NeuroNet learning, 2016). Due to the modernised world, children are exposed to multiple visual stimuli but insufficient auditory and kinesthetic stimulation, leading to deficits in correct learning processes needed to learn different subjects and complete scholastic examinations in higher grades. NeuroNet therefore aims to develop a solid foundation in all stimuli to equip foundation phase children with the necessary learning process skills (NeuroNet learning, 2016).

In summary NeuroNet is a learning readiness programme aimed at improving reading decoding, handwriting, and mathematical fact retrieval through the facilitation by movement-based learning exercises that allow the integration of rhythm, listening, speaking and workbook-based exercises to improve handwriting. The intervention programme has four main concepts:

1. **Learn independently** – Teaches children to watch and learn, then think and do by engaging in productive trial and error problem solving.
2. **Make speed and accuracy networks** – Teaches children to develop fluency in reading, handwriting and math skills from an early age. The programme also teaches adolescents how to use what they know to enhance new learning.
3. **Get the brain to practice what you want your brain to learn** – Teaches children that in order to get fluency they need to practice fluency.
4. **Self-evaluation is key to motivation** – Teaches children to self-evaluate and practice with improvements in performance.

Teachers and assistants are required to complete an accredited online course to obtain the qualifications needed to be able to implement and teach the programme, which include integrated rhythms, tools for learning, early learning and international
Schools eligible for receive accreditation as a NeuroNet accredited school and are required to implement the programme grade-wide in at least a single grade. Implementation has to occur for at least four days of the week as measured by programme usage data and all teachers implementing the programme have to successfully complete specific training to do so. Provisional status is given to schools which are in their first year of completion and become accredited thereafter. Each lesson takes approximately 20 to 30 minutes and includes activities such as integrating gross-motor movements, fine-motor movements, auditory (listening) and verbal (talking) skills to facilitate the acquisition of academic and motor skills (NeuroNet learning, 2016). The NeuroNet brochure is attached to the end of the dissertation in Appendix 8 for additional information.

2.9 DEVELOPMENT AND CURRENT STANDINGS OF INTEGRATED MOVEMENT PROGRAMMES IN SOUTH AFRICA

According to research, there is a lack of studies on relationships between visual-motor integration, perceptual-motor development, motor proficiency and literacy in writing, reading and mathematics in developing countries (Lotz, Loxton, & Naidoo, 2005:63-67; Pienaar et al., 2014:371). South Africa is seen as a developing and middle-income country with high socioeconomic discrepancies and is therefore exposed to different child development strategies compared to developed countries (Zere & McIntyre, 2003:1-10; Engle, Black, Behrman, Cabral de Mello, Gertler, Kapiriri, Martorell & Young, 2007:229-230). Children living in impoverished areas, as evident in most parts of South Africa, are exposed to a number of environmental, task and individual constraints which may interfere with cognitive and regulatory learning processes such as working memory and attention (Bronfenbrenner, 1999:16; Engle et al., 2007:230; Haywood & Getchell, 2014:255-271). These constraints include negative factors associated with poverty, including limited access to educational sources, health problems associated with poor sanitation, environmental toxin exposure, poor parenting and disorganised home environments that are not conducive to learning (Pienaar et al., 2014:371).
These constraints cause deficits in analogical reasoning, attention regulation, and poor scholastic outcomes during developmental periods (Brofenbrenner, 1999:16; UNICEF, World Health Organization & The World Bank, 2012:9-13). According to Huston (1994:988-990) deficits in perceptual-motor development occur due to limited access to learning materials and unconducive home environments. This is supported by Parush and colleagues (2000:216-231) who state that dependent variables such as the absence of stimulating home environments, inadequate schooling, specific patterns of learning practices with varying expectations of children and attitudes towards learning, different conceptualisations of appropriate behaviours and skills that should facilitate child development, all can hinder perceptual-motor and cognitive development. In 2014 the average score for a Grade 1 learner in South Africa was 63.2% in Home Language and 68.4% in Mathematics (Department of Basic Education, 2016:26). Of all the learners who completed an antinuclear antibody test, approximately 75.3% attained a score above 50% in Home Language and 80.9% in Mathematics (Department of Basic Education, 2016:26).

Research therefore indicates the need for pedagogical intervention programme implementation to allow the rectification of these apparent deficits in young children through the means of quantitative studies of good methodological design. By using valid and reliable assessment batteries that are movement-related and culture-fair, scholastic difficulties can be identified at an early age and larger-scaled country-wide interventions could be initiated to improve overall early childhood development in South Africa.

2.10 SUMMARY

With the support of the research conducted, it can be seen that there is a need for school- and or classroom-based movement interventions that incorporate visual-
motor integration, visual perception, motor coordination and proficiency in young learners in South Africa. This integrated movement approach to learning should improve the academic standing of young children in the country.
3. CHAPTER THREE: METHODOLOGY

3.1 INTRODUCTION

The following section will report on and justify the methodological procedures chosen to implement the study, population choice, sample size and procedures followed. This will include how the data was collected and analysed, and describes the steps taken to ensure the study followed the ethical principles of research.

3.2 RESEARCH DESIGN

A research design refers to the specification of steps and procedures taken to implement a study in order to achieve an anticipated outcome (De Vos, Strydom, Fouché, & Delport, 2011:143). A quasi-experimental comparison group pre-test – post-test study design was used as part of this quantitative, empirical research. The design was used as a blueprint for the basis of which data collection methods were chosen on (De Vos et al., 2011:143). Quasi-experiments allow for simpler implementations of studies to estimate causal impacts of an intervention on a specific population and allow the controlled assignment to interventions. The lack of randomisation of groups makes statistical analysis difficult in the sense that the variables investigated may not be the actual cause of the effects on the results obtained. All internal validity requirements were not met due to the lack of randomisation; bias was evident within the study as the groups were chosen due to a specific characteristic (grade one learners from two quintile five schools). This methodological approach therefore differentiates quasi-experimental designs from true experimental or randomised control trials (De Vos et al., 2011:142-153; Mangal & Mangal, 2013:127-140).
The current study was furthermore an example of a natural experiment, where a social setting such as the classroom at schools was used and manipulated to change social arrangements in a natural way to allow for observation of the development of children without drastic interference (Bryman, 2015:44-69).

Two intervention periods were implemented from Mondays to Fridays at the experimental school and consisted of scheduled twenty-minute integrated movement classes taught by the relevant grade one teacher (an internationally accredited NeuroNet learning teacher). The periods were seven and five weeks long respectively, with a two-week cessation period between the testing periods. The initial period ran from the end of July to mid-September 2017, and the consecutive period ran from mid-October to end of November 2017. Baseline assessments took place at the pre-test at the beginning of each specified term, followed by the intervention period throughout the school terms and a reassessment thereafter at the post-test at the end of the stated terms for all selected dependent variables (Mangal & Mangal, 2013:134-135).

3.3 PARTICIPANTS

The target population was grade one South African learners of both genders between the ages of six- to nine-years old attending two quintile five schools in Port Elizabeth in the Eastern Cape Province of South Africa. The experimental group comprised of 21 participants implementing the NeuroNet learning programme attending one school, and the control group comprised of 24 participants who were not exposed to the integrated movement programme attending the other specified school. Children in grade one were specifically chosen as this is the critical stage when fundamental movement skills and visual-motor integration develop. This is when children are most susceptible to optimisation of the aforementioned skills and if needed, the implementation of remedial programmes can be initiated.
3.4 SAMPLING METHODS

Convenience sampling was used for data collection as this method allowed the selection of participants that were most accessible to the researcher due to the method’s simplistic means of administration (Bryman, 2015:170-188). This method used no random process of selection and was chosen to allow for easy geographical accessibility (distance) to the specific schools targeted while accommodating financial and time constraints. Purposive sampling is the selection of participants based on specific criteria (Mangal & Mangal, 2013:291). For this study, the selection criteria were six- to nine-year-old grade one primary school children from the two specified quintile five schools in Port Elizabeth.

3.5 INCLUSION AND EXCLUSION CRITERIA

The following criteria were used to include participants into the study: Grade one learners of both genders attending a quintile five primary school already implementing the NeuroNet learning programme and whose principal provided voluntary consent for participation in the study. Grade one learners attending a second quintile five school without access to the integrated movement programme in the classroom setting.

A quintile five experimental school was specifically chosen as that school could financially afford the NeuroNet Learning Program, and a quintile five control school was chosen to standardise the level of socioeconomic background. Learners with physical injuries or who were unable to perform any one of the assessment batteries for any reason, or learners who did not provide personal assent or parental/guardian consent were excluded from the study.
3.6 MEASUREMENT INSTRUMENTS

For this study the Bruininks-Oseretsky Test of Motor Proficiency Brief Form (BOT-2 Brief Form), Beery-Buktenica Developmental Test of Visual-Motor Integration Full Form (Beery VMI), Beery-Buktenica Developmental Test of Visual-Perception (VMI-VP), and the Beery-Buktenica Developmental Test of Motor-Coordination (VMI-MC) the test batteries were used.

3.6.1 The Bruininks-Oseretsky Test of Motor Proficiency Brief Form (BOT-2 Brief Form)

The BOT-2 Brief Form was used to test the motor proficiency of the learners. The Brief form is derived from the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) and contains 12 items, consisting of at least one item from each BOT-2 Full Form subset. The test was developed to allow a reliable and efficient measurement of motor proficiency, screening and the identification of motor deficits. It is for the use of clinical research, developing and evaluating motor training programmes, as well as to be used as part of a wide-ranging battery designed to evaluate overall cognitive and academic functioning (Bruininks & Bruininks, 2010:1-2). The Brief Form was developed to provide a reliable measure of overall motor proficiency with less demands for space and materials, and allow quick and easy obtainment of scores to rate motor proficiency (Bruininks & Bruininks, 2010:19).

The BOT-2 Brief Form assesses proficiency over the following eight content areas:

- **Fine-motor Precision** – activities requiring precise control of finger and hand movement by having to draw within specific boundaries with no time limit.
- **Fine-motor Integration** – the reproduction of geometric shapes with as much accuracy as possible also requiring precise control of finger and hand movement. Since such activities require replication of shapes without
additional cues, they measure the ability to integrate motor control and visual stimuli.

- **Manual Dexterity** – goal-directed activities involving reaching, grasping, and bimanual coordination of objects such as blocks. Emphasis with such tasks is put on accuracy and efficiency within time limits. Speed and accuracy are important for the identification of disorders such as Developmental Coordination Disorder, as dexterity is used in everyday activities such as using eating utensils, sorting coins, writing, etc.

- **Bilateral Coordination** – involves the motor skills used in sports and recreational games that require body control and coordination of the upper limbs.

- **Balance** – activities that evaluate motor skills that are needed for maintaining posture during walking or reaching activities such as reaching for a cup and measures stasis, movement and the use of visual cues.

- **Speed and Agility** – activities such as hopping on one leg to identify a participant's speed and agility by assessing how quickly and efficiently they perform an activity.

- **Upper-Limb Coordination** – activities that assess visual tracking with coordinated arm and hand movement such as catching or dribbling a ball with one hand or alternating hands.

- **Strength** – activities that allow the measurement of trunk, upper and lower body strength as strength is essential for motor performance in activities of daily living.

(Bruininks & Bruininks, 2010:19).

These are all characteristics of the four motor-area domains: manual coordination, body coordination, manual control, and strength and agility. Each area of the BOT-2 Brief Form measures one of the specific and important functional motor skills. Items included are different in completion requirements but use the same muscles and limbs (Bruininks & Bruininks, 2010:2).
The equipment that was used included the administration manual, examinee response booklets, a record form for each test administrator, 15 blocks and string, a knee pad, a red pencil and sharpener, a tennis ball, a stopwatch, a tape measure, a table and chair, and 4.2 meters of non-transparent tape that was stuck linearly to the floor (Bruininks & Bruininks, 2010:3).

The BOT-2 Brief Form took approximately 20 minutes to administer and was administered individually to each participant by the researcher and trained assistants. The test consisted of the same four composite areas as the BOT-2 total motor composite test (Bruininks & Bruininks, 2010:3).

3.6.2 The Beery-Buktenica Developmental Test of Visual-Motor Integration Full Form (Beery VMI) 6th Edition and supplemental tests

The Beery VMI 6th edition was used to assess the learners’ ability to integrate visual perception and motor skills (Beery & Beery, 2010:17). Two supplemental tests, the Beery VMI Visual Perception Test (VMI-VP) and the Beery VMI Motor Coordination Test (VMI-MC) were used in conjunction with the Beery VMI test to allow the assessment of the learners’ visual perception and motor coordination respectively. It was recommended that the Beery VMI be completed first with the VMI-VP following and the VMI-MC completed last to allow the correct flow of performance. The tests were therefore administered in the stated order and scored according to a standardised criterion supplied within the testing manual. According to Beery and Beery (2010:103-133) the tests are valid and reliable as the overall average reliability was calculated from an average of the inter-rater, internal consistency test-retest scores and the average reliability scores for the tests are 0.92, 0.91 and 0.90 for the Beery VMI, the VMI-VP and the VMI-VC tests respectively. The tests required a stopwatch or a time piece with a second hand, a sharpened No.2 pencil or a ball point pen, no eraser, and the drawing booklet which was kept straight and centred.
3.6.3 Scholastic Achievement

School reports for the respective experimental- and control school participants were used for measuring scholastic achievement. The rating codes and description for recording and reporting in grades R to three as set out by the Department of Basic Education in South Africa seen in Table 1 below were used by the relevant teachers of the experimental- and control group to rate the participant’s efforts in numeracy, reading and writing (Department of Basic Education, 2011). These three scholastic domains were summated and averaged to obtain a total scholastic achievement score domain.

Table 1: Codes and description for recording and reporting in Grades R – 3

<table>
<thead>
<tr>
<th>Rating code</th>
<th>Achievement description</th>
<th>Marks %</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Outstanding achievement</td>
<td>80 - 100</td>
</tr>
<tr>
<td>6</td>
<td>Meritorious achievement</td>
<td>70 - 79</td>
</tr>
<tr>
<td>5</td>
<td>Substantial achievement</td>
<td>60 - 69</td>
</tr>
<tr>
<td>4</td>
<td>Adequate achievement</td>
<td>50 - 59</td>
</tr>
<tr>
<td>3</td>
<td>Moderate achievement</td>
<td>40 - 49</td>
</tr>
<tr>
<td>2</td>
<td>Elementary achievement</td>
<td>30 - 39</td>
</tr>
<tr>
<td>1</td>
<td>Not achieved</td>
<td>0 - 29</td>
</tr>
</tbody>
</table>

(Department of Basic Education, 2011)

3.7 INTERVENTION PROGRAMME

3.7.1 NeuroNet Learning Programme

The NeuroNet learning programme was selected as the integrated movement programme for the study. The programme was administered to the relevant experimental group participants by a NeuroNet accredited teacher and consisted of one lesson a day five times a week for approximately 20 to 30 minutes from the start of the 2017 year excluding holiday periods. The lessons included activities that incorporated integrating gross-motor movements, fine-motor movements, auditory
(listening) and verbal (talking) skills to facilitate the acquisition of academic and motor skills (NeuroNet learning, 2016). The lessons were administered to the participants from the start of the 2017 five

3.8 TESTING PROCEDURES AND SCORING

The testing procedures and scoring for the Bruininks-Oseretksy Test of Motor Proficiency Brief Form (BOT-2 Brief Form), Visual-motor integration Full Form (VMI) 6th edition, Visual-perception (VMI-VP) and Motor coordination (VMI-MC) as stated in each of their respective manuals were utilised for the purpose of the study as well as specific scholastic achievement scoring procedures. The tests were administered by the sole researcher and assistants, and were scored and interpreted by the sole researcher.

3.8.1 BOT-2 Brief Form

3.8.1.1 Testing Procedures

A series of 12 items were administered to each participant by the researcher and research assistants. Corresponding stations were set-up as follows to divide up the eight different content areas with each research assistant being consistent in which test they administered at both schools in the pre- and post-tests:

Station one (Fine-motor precision and fine-motor integration):

**Item one:** Colouring in a star without moving outside the provided lines and completely colouring in the shape.

**Item two:** Drawing a line through a curvilinear path without going out the boundaries.
**Item three:** Copying the shape of overlapping circles into a blank block below the shape.

**Item four:** Copying a diamond shape into a blank block below the shape.

**Station two (Manual dexterity and bilateral coordination):**

**Item five:** Stringing as many small red blocks as possible onto a string in 15 seconds.

**Item six:** The participants were instructed to touch the participants’ nose with index fingers only with eyes closed and alternating hands for four consecutive touches.

**Item seven:** The participants had to pivot thumbs and index fingers for five consecutive pivots without breaking both links during pivoting.

**Station three (Balance and speed and agility):**

**Item eight:** Walking forward heel-to-toe on a line of masking tape on the floor with hands on the hips while maintaining balance.

**Item nine:** One-legged side hopping over the tape line for 15 seconds with hands on the hips and the non-hopping leg remaining suspended in the air.

**Station four (Upper-limb coordination and strength):**

**Item ten:** The participants had to catch a tennis ball, thrown at a height between the knees and shoulders, with one hand without the ball touching the participant’s body for five tosses.

**Item eleven:** Dribbling a ball with alternating hands to a maximum of ten dribbles.
**Item twelve:** Maximum amount of knee push-ups in a 30 second period.

(Bruininks & Bruininks, 2010:1-29).

During items one through four no erasing was permitted, sharp pencils were used and no turning of the booklet was permitted. All tests were performed with the participants’ preferred limb for the corresponding items in station three and four and verbal cues to correct form were continuously used as feedback for the participants, as well as demonstrations of instructions if the participants were unclear on any task. Before the items were administered, verbal and nonverbal directions were provided to the participants to ensure understanding of the task requirements and the participants were given the opportunity to ask questions if unclear. Items one to four were presented sequentially in the response participant’s booklet, items six to nine and eleven were repeated a second time if the participant did not earn maximum points on the first trial, item twelve had two options (knee push-ups and full push-ups) but due to standardisation, validity, and administration ease the knee push-ups were chosen throughout the testing period (Bruininks & Bruininks, 2010:3). Items were administered sequentially from one to twelve as instructed by the manual due to the flowing order of the task requirements. This station method was kept constant for the control and experimental groups ensuring reliability and validity of the data capturing.

The BOT-2 Brief Form took 15 to 20 minutes to administer for four participants at a time (one at each station) and an extra ten minutes was needed to set up the four stations run by the assistants and researcher. The test was administered individually to each participant by the test administrators and consisted of the same four composite areas as the BOT-2 total motor composite test (Bruininks & Bruininks, 2010:3).
3.8.1.2 Scoring Procedures

The items each had specific criteria on which they were scored and each had different scoring totals as follows:

- **Item one (Filling in a star):** The participant was not allowed to exceed the boundaries provided and had to colour the star in completely with a maximum of three points being awarded for a full coloured neat star.

- **Item two (Drawing a line through a path):** The participant had to draw a solid line within the path boundaries provided and was penalised accordingly for each break through the boundary or coloured in path. For each 1.27cm break a one point penalty was awarded, for each 2.54cm break a two-point penalty, for each 3.81cm break a three-point penalty, and so forth.

- **Item three (Copying overlapping circles):** The item was scored according to six criteria in which the participant scored either a one or zero for each criterion. The criteria were firstly basic shape - a one was scored if the shapes represented circles with no corners and did not have to overlap to get a one score, secondly closure - one was scored if there were no gaps (or each gap less than 0.3175cm) and no overlaps (or less than 0.635cm), thirdly edges - a one was scored if the two circles were about the same size and neither had a longer diameter that was three or more times longer than the shortest diameter or if the larger circle was less than twice the size of the smaller circle, fourthly orientation - a one was scored if the circles were directly beneath each other and a zero otherwise, fifthly overlap – a one was score if the overlap drawn was similar to the stimulus overlap, and lastly overall size – a one was scored if the overall size of the drawing was at least half the size of the stimulus. The subject therefore scored a total out of six points.
• **Item four (copying a diamond):** This consisted of the same scoring criteria as the overlapping circles with the overlap criteria being omitted. The subject therefore scored a total out of five points.

• **Item five (Stringing blocks):** The subject only had 15 seconds to complete the task and had 15 blocks for stringing. The blocks did not need to be pushed to the end of the string and the administrator could hold the end of the string to prevent tangling. The number of maximum blocks strung out of two trials was recorded.

• **Item six (touching nose with index fingers-eyes closed):** The number of correct touches were recorded up to four. A touch was incorrect if a participant’s eyes were opened, if the movement was not continuous, if the tip of the nose was not touched and rather the face as well as with the index fingers, failed to alternate arms, failed to extend arms fully after touching the nose or moved head to meet the index finger. If an incorrect touch occurred, the trial was stopped and the participant was reminded of the correct form by the administrator and allowed to participate in a second trial.

• **Item seven (Pivoting thumbs and index fingers):** The number of correct pivots were recorded until the maximum five pivots. A pivot was incorrect if the participant failed to maintain a continuous movement, failed to place thumbs or index fingers correctly, or allow the pivoting thumb and index finger to separate prematurely. If an incorrect pivot occurred, the participant was reminded of the correct form by the administrator and allowed to participate in a second trial.

• **Item eight (Walking forward heel-to-toe on a line):** A maximum number of six correct steps could be recorded. A step was incorrect if the participant failed to step heel-to-toe, stepped off the line, failed to keep the hands on the waist, stumbled or fell. If an incorrect step occurred, the participant was reminded of the correct form by the administrator and allowed to participate in a second trial.
• **Item nine (One-legged side hop):** The number of correct hops in 15 seconds was recorded. A hop was incorrect if the participant touched the raised foot to the floor, failed to keep the hands on the waist or failed to attain sideways movement of at least 10.16cm. If the participant stumbled or fell, the administrator instructed the participant to resume the one-legged side hops and a second trial was done. If the participant touched the line or drifted forward or backward while hopping sideways, the hops were counted as correct if a sideways movement of at least 10.16cm was maintained.

• **Item ten (Catching a tossed ball- one hand):** A total of up to five inconsecutive correct catches were recorded. A catch was deemed incorrect if the participant caught the ball against the participant’s body, caught with two hands or if caught with the non-preferred hand. A throw was re-administered if the ball was thrown above the shoulders, below the knees or out of reach of the participant.

• **Item eleven (Dribbling a ball- alternating hands):** A score of up to ten correct dribbles were recorded. A dribble was incorrect if the participant did not use alternative hands for each dribble, caught the ball, or allowed the ball to bounce more than once between dribbles. If an incorrect dribble occurred, the trial was stopped and the participant was reminded of correct form and a second trial was administered.

• **Item twelve (Knee push-ups):** Initially the knee-push up was demonstrated within a class setting and then individually before the test conduction for each participant. The number of correct knee push-ups performed in thirty seconds was recorded. A knee push-up was viewed as incorrect if the participant lifted the hips so that the back was not straight or allowed the back to sag. If incorrect
form occurred the administrator stopped the test, demonstrated the correct form again and continued the trial.

(Bruininks & Bruininks, 2010:1-29).

Raw scores obtained from the BOT- Brief Form testing were converted to numerical point scores to provide total composite scores for motor proficiency. These were assessed through the use of the normative data provided in the administration manual and were expressed either as a percentile rank, z-score, t-score or age equivalent and placed each participant in a descriptive category ranging from well below average to well above average (Bruininks & Bruininks, 2010:11-16).

3.8.2 Beery VMI

3.8.2.1 Testing Procedures

The full-form Beery VMI contained three initial types of marking and scribbling which were not graded and therefore not completed as these were only to be completed by children under the age of five, three practice forms which were demonstrated by an administrator and were copied directly, thereafter 15 scored test forms each participant had to complete by themselves (Beery & Beery, 2010:18-29). It required 10 to 15 minutes to be completed and was administered to the learners in a group setting as a class before starting the BOT-2 Brief Form test. The concept of the test was for participants to copy geometric figures which initially were simple and increased in complexity as the test progressed. The test began with the participants at their respective desks, only using a sharp HB pencil with no erasers at hand and their test booklets on the first page which contained six blank square blocks. The administrator explained the concepts of copying the exact shape they saw in the empty blocks presented without exiting the blocks and trying to make the shape seen and the shape drawn the exact same size. The initial three scribbling items were excluded from the test as this had no scoring significance and limited the time available for testing. The
participants were instructed to copy the three figures the administrator drew on the chalk board, as these were the three practice trials. After the completion of these, the participants were instructed to put their hands on their heads and wait for each participant to be finished. Thereafter, to turn the page to the next six blocks which had printed figures in the top three blocks and were to be copied in the block directly beneath each respected figure. The first three scored shapes were the same as the practice shapes to familiarise the participants with the procedure of the test and became increasingly more difficult thereafter. After drawing the respective three shapes on the respective pages the participants were instructed to put their hands on their heads until the administrator instructed them to turn the page and continue copying. This process was continued until all 21 items were copied. The participants were only allowed one trial for each shape and were not allowed to erase any markings made. Each participant was instructed to ensure the booklet was completed (Beery & Beery, 2010:18-25).

3.8.2.2 Scoring Procedures

According to the Beery VMI manual the first three shapes did not have to be completed by children under the age of five and the first three shapes were practice shapes, therefore each participant was automatically given six points to start with before the assessment of the following 15 scored shapes (Beery & Beery, 2010:18-29). Each relative copied shape was critically analysed by the sole researcher and was scored as either being successful and awarded a score of one point or unsuccessful and rated as zero score according to the criteria stated on pages 30 to 59 in the Beery VMI manual (Beery & Beery, 2010:30-59). After three consecutive failures, the scoring was stopped as indicated by the manual and notes were made in the comment boxes if a zero score was indicated as to why that shape did not qualify. The raw scores for each booklet were cumulated to a total out of 21 (15 scored shapes and six starting points). The raw scores were then converted to standard scores using the distribution tables provided in the Beery VMI manual on pages 188 and 190 which based the conversion on each participants age range, for example 7:0 to 7:1 meaning from seven years to seven years and one month old (Beery & Beery, 2010:188,190). The standard
scores were then recorded and statistically interpreted as discussed in the next section.

According to Beery and Beery (2010:18) the re-administration of the test should be at least one month after the pre-test to allow the normative data to be valid. The post-tests at each school were therefore done more than a month after the pre-tests for each school to ensure validity of the study.

3.8.3 Beery VMI Visual Perception Test (VMI-VP)

3.8.3.1 Testing Procedures

The first supplemental test was completed sequentially after the Beery-VMI test. The first three items were practice items where the sole researcher verbally and physically explained to the participants how the process of item selection was done and were guided through items four to six to ensure the participants were doing the process correctly. The participants started the test independently at item seven and ended at item thirty. Each participant had to identify which geometric shape below the displayed test shape was identical to the test shape. Items seven to nine had two shapes to choose from, items ten to thirteen had three, items fourteen to sixteen had four, items seventeen to twenty-one had five, items twenty-two to twenty-seven had six and items twenty-eight to thirty had seven geometric shapes to choose from. The participants had three minutes to identify as many correct shapes as possible.

3.8.3.2 Scoring Procedures

One point was awarded for items four to thirty when identified correctly within the three-minute period, unless three consecutive incorrect items were identified, where the scoring for that participant terminated at the third consecutive fault. Three points were
given to each participant by default for items one to three, and a maximum of thirty points could have been awarded.

3.8.4 Beery VMI Motor Coordination Test (VMI-MC)

3.8.4.1 Testing Procedures

The second supplemental test was administered sequentially after the Beery-VMI and VMI-VP tests. The test consisted of the participants drawing within geometric shapes provided from a black dot to the corresponding grey dots after the sole researcher had verbally and physically instructed on how to do so. The same concept of three practice trials with three assisted trials was used with participants starting at item seven and having five minutes to complete as many shapes as possible up to item thirty.

3.8.4.2 Scoring Procedures

One point was awarded for items four to thirty when drawn correctly within the specified geometric lines. A point was not awarded if the participant went outside the specified lines, did not connect the relevant dots or misinterpreted the corresponding shapes outline. Unlike the VMI-VP, scoring continued even if three consecutive mistakes were made. Three points were given to each participant by default for items one to three, and a maximum of thirty points could have been awarded.

3.8.5 Scholastic Achievement

Scholastic performance was measured using the results extracted as scores from each participant’s school report in numeracy, reading and writing pre- and post-intervention. The reports were written and graded by the relevant school class teachers each term over which the intervention took place. As recommended by the Department of Basic Education (2015), learners from grade R to grade three should be rated and reported on their scholastic performance according to a specific coding
table as seen in Table 1 displayed in the above in section 3.6.3. Teachers at both schools used the recommended criteria for scoring scholastic achievement of the learners in literacy, numeracy, reading and writing

3.9 VALIDITY AND RELIABILITY

3.9.1 Motor Proficiency

According to research conducted by Mayson (2007:1-2), the BOT-2 Brief Form has an established reliability and that the tests have split-half reliability for internal consistency which show reliability coefficients for the subscale, composite, total motor composite and Brief Form scores that range from high 0.70s to mid-0.90s. Test-retest reliability correlation scores of cognitive, language and motor scales vary according to children’s ages and range from 0.69 to 0.80s for subscale scores and from mid to upper 0.80s for total motor composite and Brief Form reliability. Inter-rater reliability coefficients range from 0.92 to 0.99 and have standard deviations of less than 0.02. Validity studies done also show overall total motor composite and battery composite correlations of 0.80 and correlations between similar fine and gross-motor composites showed correlations between -0.59 and 0.73, excluding the manual coordination composite which did not have an equivalent on the VMI-MC and correlates best with the gross-motor composite at 0.60. Subsets correlations ranged from 0.45 to 0.73, overall validity of the BOT-2 Brief Form is strong (Mayson, 2007:1-2).

Bruininks and Bruininks (2010:25-28) also indicate very high (0.98 and 0.97) inter-rater reliability coefficients. For the Brief Form, internal consistency reliabilities are generally in low to mid-80s and standard errors of measurement range from 2.93 to 4.97 (Bruininks & Bruininks, 2010: 25).
3.9.2 Visual-motor Integration

The Beery VMI and supplemental tests are valid and reliable as the overall average reliability was calculated from an average of the interrater, internal consistency and test-retest scores and the average reliability score for the test battery was 0.92 (Beery & Beery, 2010:103-108,133). All three tests were standardised on national samples of 2,512; 1,021 and 1,737 individuals and have established reliability and validity (Beery & Beery, 2010:16).

3.9.3 Scholastic Achievement

For this study the scores on the academic reports compiled by the respective school teachers were utilized to measure scholastic achievement. These reports were recorded according to the codes and description for recording and reporting in grades R-3 set out by the Department Of Basic Education as displayed in Table 1 section 3.6.3. There was no true validation for internal consistency and reliability within these teaching contexts.

3.10 PILOT STUDY AND DATA COLLECTION

To establish interrater, test-retest and internal consistency reliability, prior to research data collection, the researcher of this study was trained accordingly in the BOT-2 Brief Form test battery and three Beery VMI tests and was evaluated by a post-doctoral supervisor and qualified biokineticist with experience in the use of the relevant tests. The pilot tests were done on 25 participants at one quintile five school (experimental) and on 20 participants at another quintile five school (control) in Port Elizabeth. None of the participants’ data was included in the data analysis of the dissertation. The pilot study was done after receiving consent, assent and permission from the Department of Basic Education, the Nelson Mandela University and the Faculty of Health Sciences Postgraduate Student Committee and the Nelson Mandela University Ethics Committee (H16-HEA-HMS-001). Each participatory school principal provided
approval for participation in the proposed study. This served as a pilot study for the master’s study to evaluate the feasibility, time, cost, and potential adverse events that could occur during assessment. Furthermore, to ensure the research design allowed the most efficient method of data collection to be established (Thomas, Nelson, & Silverman, 2011:278-279).

3.11 DATA ANALYSIS

The Stat Soft, Inc. (2014) statistical package with the statistical significance set within a 95% interval (p<0.05) was used in conjunction with the consultation of a qualified statistician based at the Nelson Mandela University’s Unit for Statistical Consultation for the accurate analysis and interpretation of the data.

Descriptive statistics allow the representation of basic features of data within a study and allow the creation of simple summaries about the sample and measures through organising, summarising and presenting data in an appropriate and informative way (Keller, 2014:2). There are two general types of descriptive statistics and these include measures of dispersion and measures of central tendency which includes the mean, median and mode of sample data (Keller, 2014:2). Inferential statistics are methods used to make conclusions and inferences about a population’s characteristics based on sample data and these include tests such as t-tests, ANOVA tests, Chi-square tests, Cohen’s d and Cramer’s V comparisons (Keller, 2014:4).

Central tendency and measures of central tendency as a means of descriptive statistics was utilised to describe the data collected. Pre-test and post-test results were compared for the experimental (intervention) and control (comparison) group to determine if the changes that occurred within the selected variables, could have been ascribed to the NeuroNet Learning Programme implementation or other extraneous variables. ANOVA statistical tests were used to determine whether any significant
differences between the averages of the two independent groups existed. Post hoc analysis was used where appropriate for comparison purposes (Keller, 2014:533). Cohen’s d is an effect size, and was used to indicate the standardised difference between the means of the two groups to accompany the ANOVA analysis performed (Bryman, 2015:130-148). Subsequent interpretation categories for Cohen’s d were d<0.20 (insignificant effect), 0.20≤d<0.50 (small effect), 0.50≤d<0.80 (medium effect) and d≥0.80 (large effect) (Gravetter & Wallnau, 2009). Pearson correlation coefficients for group similarities were performed, Chi-square values were used to ascertain whether distributions of categorical variables differed from one another and Cramer’s V was applied to determine correlation in tables which had more than two-by-two rows and columns.

3.12 ETHICAL CONSIDERATIONS

The four pillars of ethics, namely autonomy, beneficence, non-maleficence and justice, were maintained throughout the study. Children under the age of 18 are a vulnerable population group and for the current study caution was therefore taken for injury prevention, infringements of rights, all participants were treated equally and equitably. A detailed verbal explanation of the aims, objectives, benefit to the learners, and methods and procedures of the study was done to both the participants and parents or guardians with accompaniment of fully disclosed letters of assent and consent that were signed by the relevant participants and parents/guardians respectively. Oral assent was completed by the participants (Appendix 3). Accommodation was made for illiteracy as the information sheet (Appendix 2) was read aloud to the parent/guardian and if needed, an oral translation of this sheet into the colloquial language of the guardian was provided. All personal information of the participants was and will continue to be kept anonymous and was solely revealed to the researcher, research supervisor and statistician. Plagiarism was prevented, and all literature referenced is included and acknowledged by means of the reference list.
A proposal was submitted to the Faculty of Health Sciences Postgraduate studies committee prior to implementation of testing and data collection, and permission was granted for the completion of the master's study by the Nelson Mandela University Faculty Research, Technology and Innovation Committee and the Nelson Mandela University Research Ethics Committee: Human (REC-H) for proceeding of the study. The ethics clearance reference number was: H17-HEA-HMS-001 as can be seen in the approval letter in appendix 9. The Eastern Cape Department of Basic Education and the schools involved also approved the research (Appendix 4, 5, 6, and 7).

3.13 SUMMARY

As can be noted from the methodology, the research followed a comparison group pre-test – post-test quasi-experimental design of 45 learners in total consisting of 21 participants from an experimental and 24 participants from a control group from two quintile five schools in Port Elizabeth. The data collection method was convenience and purposive sampling, and descriptive and inferential statistical analyses were performed on the results obtained. The BOT-2 Brief Form and Beery VMI with established reliability and validity scores were used for testing purposes after a pilot study which served as training for the administrators was done.
4. CHAPTER FOUR: RESULTS

4.1 INTRODUCTION

Chapter 4 represents the results of the statistical data analysis of the participants of the study. Data obtained consisted of BOT-2 Brief Form scores for motor proficiency, Beery VMI scores for visual-motor integration and scholastic achievement scores for numeracy, reading, writing, as well as total scholastic achievement scores. The scores were statistically interpreted and expressed as contingency tables. Contingency tables are tables showing the distribution of a single variable in rows and another variable in columns for the use of studying the correlation between variables (Keller, 2014:607). The data was further analysed using t-tests, ANOVA tests, Cohen’s d, and Chi-square tests with significance levels of <0.05 as discussed in the sections to follow. Findings are indicative of the effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth.
Table 2: Key for the statistical abbreviations to be used in the results section

<table>
<thead>
<tr>
<th>Key</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Acad</td>
<td>Scholastic achievement</td>
</tr>
<tr>
<td>Control Grp</td>
<td>Control group</td>
</tr>
<tr>
<td>Cohen’s d</td>
<td>Effect size used to indicate the standardised difference between two means</td>
</tr>
<tr>
<td>Chi²</td>
<td>Chi-square value</td>
</tr>
<tr>
<td>d.f.</td>
<td>Degrees of freedom</td>
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<tr>
<td>Diff</td>
<td>Difference</td>
</tr>
<tr>
<td>Exp Grp</td>
<td>Experimental group</td>
</tr>
<tr>
<td>MC</td>
<td>Motor Coordination</td>
</tr>
<tr>
<td>Mean</td>
<td>Average</td>
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<tr>
<td>n</td>
<td>Total number of participants</td>
</tr>
<tr>
<td>N</td>
<td>Numeracy</td>
</tr>
<tr>
<td>p</td>
<td>p-value</td>
</tr>
<tr>
<td>Pre1</td>
<td>Pre-test 1</td>
</tr>
<tr>
<td>Post1</td>
<td>Post-test 1</td>
</tr>
<tr>
<td>Pre2</td>
<td>Pre-test 2</td>
</tr>
<tr>
<td>Post2</td>
<td>Post-test 2</td>
</tr>
<tr>
<td>MP</td>
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</tr>
<tr>
<td>R</td>
<td>Reading</td>
</tr>
<tr>
<td>±S.D</td>
<td>±Standard deviation</td>
</tr>
<tr>
<td>t</td>
<td>t-Test result</td>
</tr>
<tr>
<td>T</td>
<td>Total</td>
</tr>
<tr>
<td>V</td>
<td>Cramer’s V</td>
</tr>
<tr>
<td>VMI</td>
<td>Beery VMI</td>
</tr>
<tr>
<td>VP</td>
<td>Visual Perception</td>
</tr>
<tr>
<td>W</td>
<td>Writing</td>
</tr>
</tbody>
</table>

4.2 RESULTS FOR AGE AND GENDER RELATED CHANGES

As stated in chapter 2, children mature at different rates and therefore this could have potential effects on their visual-motor integration, motor proficiency and scholastic achievement performances. Due to unpredictable developmental rates, age as a potential factor influencing children’s motor and cognitive abilities was explored and the results are expressed below.
Table 3: t-Tests for chronological age comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen's d</th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>7,24</td>
<td>±0,37</td>
<td>0,06</td>
<td>0,56</td>
<td>43</td>
<td>,581</td>
<td>not applicable</td>
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<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>7,19</td>
<td>±0,33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>7,39</td>
<td>±0,37</td>
<td>0,08</td>
<td>0,77</td>
<td>43</td>
<td>,446</td>
<td>not applicable</td>
<td></td>
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<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>7,31</td>
<td>±0,33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre2</td>
<td>Exp Grp</td>
<td>21</td>
<td>7,49</td>
<td>±0,37</td>
<td>0,08</td>
<td>0,77</td>
<td>43</td>
<td>,444</td>
<td>not applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>7,41</td>
<td>0,33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post2</td>
<td>Exp Grp</td>
<td>21</td>
<td>7,58</td>
<td>±0,37</td>
<td>0,07</td>
<td>0,69</td>
<td>43</td>
<td>,493</td>
<td>not applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>7,51</td>
<td>±0,32</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Key**

<table>
<thead>
<tr>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Grp</td>
</tr>
<tr>
<td>Cohen’s d</td>
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<tr>
<td>d.f.</td>
</tr>
<tr>
<td>Diff</td>
</tr>
<tr>
<td>Exp Grp</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>n</td>
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<tr>
<td>p</td>
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<tr>
<td>Pre1</td>
</tr>
<tr>
<td>Post1</td>
</tr>
<tr>
<td>Pre2</td>
</tr>
<tr>
<td>Post2</td>
</tr>
<tr>
<td>±S. D</td>
</tr>
<tr>
<td>t</td>
</tr>
</tbody>
</table>

Table 3 represents the average age and standard deviation of the participants during each testing period. The results indicated that the participants were aged between six-to seven-years-old and the experimental- and control group had no significant difference in age of the participants.
Table 4: Contingency table for gender differences in the experimental- and control group

<table>
<thead>
<tr>
<th>School</th>
<th>Gender</th>
<th>n - Female</th>
<th>Percentage (%)</th>
<th>n - Male</th>
<th>Percentage (%)</th>
<th>n - Total</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp Grp</td>
<td></td>
<td>10</td>
<td>48%</td>
<td>11</td>
<td>52%</td>
<td>21</td>
<td>100%</td>
</tr>
<tr>
<td>Control Grp</td>
<td></td>
<td>13</td>
<td>54%</td>
<td>11</td>
<td>46%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>23</td>
<td>51%</td>
<td>22</td>
<td>49%</td>
<td>45</td>
<td>100%</td>
</tr>
</tbody>
</table>

Chi²(d.f. = 1, n = 45) = 0.19; p = .661

Key

<table>
<thead>
<tr>
<th>Definition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Grp</td>
<td>Control group</td>
</tr>
<tr>
<td>Chi²</td>
<td>Chi-square value</td>
</tr>
<tr>
<td>d.f.</td>
<td>Degrees of freedom</td>
</tr>
<tr>
<td>Exp Grp</td>
<td>Experimental group</td>
</tr>
<tr>
<td>n</td>
<td>Total number of participants</td>
</tr>
<tr>
<td>p</td>
<td>p-value</td>
</tr>
</tbody>
</table>

Table 4 presents the frequency of boys and girls in each of the experimental- and control groups. The results indicate that there is a relatively even distribution of boys and girls throughout the groups. According to the above statistics, age and gender were therefore not significant contributing factors to the interpretation of results between the experimental- and control groups, as these factors were the same for both groups.
4.3 RESULTS FOR MOTOR PROFICIENCY

Motor proficiency is the ability to complete complex and fine-motor skills through the acquisition of complex integrated movement patterns (Bruininks & Bruininks, 2010:12; Venetsanou & Kambas, 2016:14-20). Motor proficiency aids development of motor control and can be used as an index of a child’s motor development (Bruininks & Bruininks, 2010:12; Venetsanou & Kambas, 2016:14-20). The BOT-2 Brief Form test battery was used as the measuring instrument for motor proficiency. Comparisons of the test battery scores for the experimental- and control group over the two intervention periods can be seen below in Table 5.

Table 5: t-Test comparisons for motor proficiency between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>60,95</td>
<td>±12,09</td>
<td>±16,76</td>
<td>15,70</td>
<td>3,56</td>
<td>,001</td>
<td>1,06</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>45,25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>MP Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>65,33</td>
<td>±17,95</td>
<td>±16,71</td>
<td>11,46</td>
<td>2,22</td>
<td>,032</td>
<td>0,66</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>53,88</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>MP Pre2</td>
<td>Exp Grp</td>
<td>21</td>
<td>63,10</td>
<td>±12,12</td>
<td>±16,12</td>
<td>13,68</td>
<td>3,18</td>
<td>,003</td>
<td>0,95</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>49,42</td>
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<td>Large</td>
</tr>
<tr>
<td>MP Post2</td>
<td>Exp Grp</td>
<td>21</td>
<td>71,57</td>
<td>±12,37</td>
<td>±17,12</td>
<td>16,70</td>
<td>3,70</td>
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<td>1,11</td>
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<td></td>
<td>Control Grp</td>
<td>24</td>
<td>54,88</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>MP Diff Post1-Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>4,38</td>
<td>±17,11</td>
<td>±17,56</td>
<td>-4,24</td>
<td>-</td>
<td>,418</td>
<td>not applicable</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>8,63</td>
<td></td>
<td></td>
<td></td>
<td>0,82</td>
<td></td>
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</tr>
<tr>
<td>MP Diff Pre1-Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>-2,24</td>
<td>±13,38</td>
<td>±12,36</td>
<td>2,22</td>
<td>0,58</td>
<td>,566</td>
<td>not applicable</td>
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<tr>
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<td>Control Grp</td>
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<td>-4,46</td>
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<td>MP Diff Post2-Pre2</td>
<td>Exp Grp</td>
<td>21</td>
<td>8,48</td>
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</table>

Table 5 represents the statistical comparisons between the pre- and post-test scores for the BOT-2 Brief Form percentile rankings assessing motor proficiency over the two intervention periods. The results indicate that motor proficiency showed a mean increase of 10.62±13.97 (24% improvement) in the experimental group compared to a mean increase of 9.63±13.26 (8% improvement) in the control group. A significant final mean between-group difference in motor proficiency was found (Diff=16.70, t(43)=3.70, p=0.001; Cohen’s d=1.11: large effect size). A decline of 2.24±13.38 in the experimental group and a decline of 4.46±12.36 in the control group was seen during the break between the first and second intervention period. The participants started school holidays after the first post-test and the second pre-test was initiated when the schools commenced. The decline in percentile ranking occurred during this holiday.
period and may be linked to the participants not being stimulated as effectively in home environments as with school, therefore failing to retain adaptations.

Although a decline occurred over the holiday period, motor development had occurred, and motor skills were retained as the mean increases in motor proficiency for the two groups were significant (p<0.05). There was a significant difference in initial pre-test values between the two groups (Diff=15.70, t(43)=3.56, p=0.001; Cohen’s d=1.06: large effect size), indicating the experimental group had a higher initial rating for motor proficiency. The final between group motor proficiency scores were similarly significant (Diff=16.70, t(43)=3.70, p=0.001; Cohen’s d=1.11: large effect size). The experimental group experienced a higher overall mean improvement of 10.62±13.97 in motor proficiency, compared to 9.63±13.26 of the control group, possibly indicating the integrated movement programme had positive effects on the participants’ motor proficiency.

4.3.1 Motor Proficiency Categorisation Changes

Table 6 and 7 on the following pages illustrate the number of participants in each of the BOT-2 Brief Form descriptive categories ranging from well below average to well above average according to the standardised norms for the experimental- and control groups. These categories are representative of motor proficiency changes within the two groups and the effect the integrated movement programme could possibly have had on the experimental group.
Table 6: Motor Proficiency Descriptive Category Frequency Distributions for the Experimental Group (n = 21)

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre1</th>
<th>Post1</th>
<th>Pre2</th>
<th>Post2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well below average</td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Below average</td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Average</td>
<td>21 100%</td>
<td>18 86%</td>
<td>20 95%</td>
<td>16 76%</td>
</tr>
<tr>
<td>Above average</td>
<td>0 0%</td>
<td>3 14%</td>
<td>1 5%</td>
<td>5 24%</td>
</tr>
<tr>
<td>Well above average</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
</tr>
</tbody>
</table>

Table 6 indicates that initially all participants in the experimental group were rated as average in motor proficiency. After the first intervention period, 14% of the participants in the experimental group had improved to above average. During the school holidays there was a decrease of 11% in motor proficiency of the experimental group. After the second intervention period a significant increase in motor proficiency occurred (p=0.001; Cohen’s d=1.11: large effect size) and 24% of the participants were rated as above average and 76% rated average. These results therefore indicate that the integrated movement programme had a positive effect on overall motor proficiency over each of the intervention periods for the experimental group.

Table 7: Motor Proficiency Descriptive Category Frequency Distributions for the Control Group (n = 24)

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre1</th>
<th>Post1</th>
<th>Pre2</th>
<th>Post2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well below average</td>
<td>0 %</td>
<td>1 4%</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Below average</td>
<td>23 96%</td>
<td>23 96%</td>
<td>23 96%</td>
<td>22 92%</td>
</tr>
<tr>
<td>Average</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>2 8%</td>
</tr>
<tr>
<td>Above average</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
</tr>
<tr>
<td>Well above average</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
</tr>
</tbody>
</table>
Table 7 illustrates that 4% of the participants in the control group were rated as having below average motor proficiency and 96% of the participants were rated as average in the initial motor proficiency measurement. There was no change in descriptive categories over the first intervention and holiday periods, indicating the participants’ motor proficiencies remained the same over this time. Over the second intervention period an 8% increase in motor proficiency was seen.

The results in Table 6 and 7 indicate that motor proficiency increased by 24% in the experimental group and 8% in the control group over the duration of the study. This significant improvement (p=0.001) is therefore possibly due to the integrated movement programme having positive effects on the experimental groups’ motor proficiency and retention of the acquired skills.

4.4 RESULTS FOR VISUAL-MOTOR INTEGRATION

Visual-motor integration is the combination of visual perception and motor proficiency to allow efficient hand-eye coordination to complete certain tasks (Capellini, Giaconi & Germano, 2017:258-259). Motor proficiency and visual perception are therefore important for proper child development and play a large role in the efficiency of every day actions (Coetzee & Du Plessis, 2013:37-40; Pienaar & Kemp, 2014:167-168). The Beery VMI test battery was used to measure overall visual-motor integration, and the two supplemental tests, VMI-VP and VMI-MC, were used to measure visual perception and motor coordination as sub-tests. Results pertaining to the identification whether the integrated movement programme had significant effects on visual-motor integration, visual perception and motor coordination are displayed in the tables 9, 10 and 11 below.
Table 8 below indicates the different numerical interval ranges for Cohen’s d for the interpretation of the results to follow.

### Table 8: Interpretation intervals for Cohen’s d

<table>
<thead>
<tr>
<th>Interval</th>
<th>Effect</th>
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<tbody>
<tr>
<td>&lt;0.20</td>
<td>Not significant</td>
</tr>
<tr>
<td>0.20 - 0.49</td>
<td>Small effect</td>
</tr>
<tr>
<td>0.50 - 0.79</td>
<td>Medium effect</td>
</tr>
<tr>
<td>0.80+</td>
<td>Large effect</td>
</tr>
</tbody>
</table>

(Gravetter & Wallnau, 2009:264)
Table 9 below shows comparable (average percentile ranks) results for visual-motor integration for both the experimental- and control group prior to and post-intervention for school terms three and four.

Table 9: t-Test visual-motor integration comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean ±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMI Percentile</td>
<td>Exp Grp</td>
<td>21</td>
<td>43,57 ±13,34</td>
<td>0,03</td>
<td>0,01</td>
<td>43</td>
<td>.994</td>
<td>not applicable</td>
</tr>
<tr>
<td>Pre1</td>
<td>Control Grp</td>
<td>24</td>
<td>43,54 ±12,53</td>
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</tr>
<tr>
<td>VMI Percentile</td>
<td>Exp Grp</td>
<td>21</td>
<td>45,71 ±13,64</td>
<td>12,40</td>
<td>2,79</td>
<td>43</td>
<td>.008</td>
<td>0,84 Large</td>
</tr>
<tr>
<td>Post1</td>
<td>Control Grp</td>
<td>24</td>
<td>33,31 ±15,83</td>
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</tr>
<tr>
<td>VMI Percentile</td>
<td>Exp Grp</td>
<td>21</td>
<td>40,14 ±11,19</td>
<td>-2,69</td>
<td>-0,75</td>
<td>43</td>
<td>.457</td>
<td>not applicable</td>
</tr>
<tr>
<td>Pre2</td>
<td>Control Grp</td>
<td>24</td>
<td>42,83 ±12,67</td>
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<tr>
<td>VMI Percentile</td>
<td>Exp Grp</td>
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<td>38,19 ±10,22</td>
<td>3,52</td>
<td>0,97</td>
<td>43</td>
<td>.336</td>
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<td>Control Grp</td>
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<td>34,67 ±13,58</td>
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<td>VMI Percentile</td>
<td>Exp Grp</td>
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<td>2,14 ±19,60</td>
<td>12,37</td>
<td>2,49</td>
<td>43</td>
<td>.017</td>
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<tr>
<td>Diff Post1-Pre1</td>
<td>Control Grp</td>
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<td>-10,23 ±13,49</td>
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<tr>
<td>VMI Percentile</td>
<td>Exp Grp</td>
<td>21</td>
<td>-5,57 ±12,60</td>
<td>-15,09</td>
<td>-3,42</td>
<td>43</td>
<td>.001</td>
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<td>VMI Percentile</td>
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<td>-1,95 ±9,43</td>
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<td>-5,38 ±14,34</td>
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</table>

The results displayed in table 9 indicate that there was no significant difference between initial visual-motor integration percentiles (Diff=0.03, t(43)=0.01, p=0.994; Cohen’s d=not applicable). There was an average increase in visual-motor proficiency of 2.14±19.60 in the experimental group and a decrease of 10.23±13.49 in the control group over the first intervention period (Diff=2.37, t(43)=2.49, p=0.017; Cohen’s d=0.74: medium effect size). Over the second intervention period there was an average decrease of 1.95±9.43 in the experimental group and 8.17±15.26 in the control group. Over the duration of the study the experimental group experienced a total decrease of 5.38±14.34 and the control group a total decrease of 8.88±15.39 in visual-motor proficiency. The results therefore indicate that the integrated movement programme potentially had no effect on visual-motor integration in the experimental group.
4.4.1 Visual Perception

The Table 10 below shows comparable (average percentile ranks) results for visual perception as a subset of visual-motor integration for both the experimental- and control group prior to and post-intervention for school terms three and four.

Table 10: t-Test visual perception comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP Percentile Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>76,95</td>
<td>±21,24</td>
<td>30,29</td>
<td>3,90</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1,16</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>46,67</td>
<td>±29,54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
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<tr>
<td>VP Percentile Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>79,59</td>
<td>±21,49</td>
<td>15,21</td>
<td>2,32</td>
<td>43</td>
<td>0,025</td>
<td>0,69</td>
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<td>±29,05</td>
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<td>VP Percentile Diff Post1- Pre1</td>
<td>Exp Grp</td>
<td></td>
<td>21</td>
<td>2,63</td>
<td>±15,81</td>
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<td>±25,11</td>
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<td></td>
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<td>±16,08</td>
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<td>±13,67</td>
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<tr>
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<td>Exp Grp</td>
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<td>-3,89</td>
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</tbody>
</table>
The results illustrated in Table 10 indicate that the experimental group had higher mean values for the visual perception tests in both pre- and post-test, and there was a significant difference between the experimental- and control group means in the initial test (Diff=30.29, t(43)=3.90, p<0.0005; Cohen’s d=1.16: large effect size), first post test (Diff=5.21, t(43)=2.32, p<0.025; Cohen’s d=0.69: medium effect size), second pre-test (Diff=21.90, t(43)=3.47, p=0.001; Cohen’s d=1.04: large effect size), and final post- test (Diff=26.40, t(43)=3.95, p<0.0005; Cohen’s d=1.18: large effect size). There was an average increase in visual perception of 2.63±15.81 in the experimental group and 17.71±25.11 in the control group during the first intervention period. Over the second intervention period there was an average increase of 0.58±16.12 in the experimental group and an average decrease of 3.92±13.67 in the control group. In the total duration of the study, the experimental group experienced a total increase of 11.82±18.81 and the control group a total increase of 15.71±30.03 in visual perception. There is no significant evidence that the integrated movement programme was the cause of the increase in visual perception in the experimental group and the increases seen may have been due to the learning effect throughout the schooling terms three and four in both groups.
4.4.2 Motor Coordination

Table 11 below shows comparable (average percentile rank) results for motor coordination as a subset of visual-motor integration for both the experimental- and control group prior to and post-intervention for school terms three and four.

Table 11: t-Test motor coordination comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen’s d</th>
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<tr>
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<td>Exp Grp</td>
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<td>±13,97</td>
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<td>Exp Grp</td>
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<td>Exp Grp</td>
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</table>

The results indicate that there was no significant difference between initial motor coordination rankings (p=0.705). There was an average increase in motor coordination of 35.05±15.76 in the experimental group and 3.17±29.50 in the control group over the first intervention period. Over the second intervention period there was an average decrease of 3.76±17.94 in the experimental group and an average increase of 15.00±20.33 in the control group. Over the duration of the study the experimental group experienced a total increase of 20.00±18.45 and the control group a total decrease of 1.50±23.74 in motor coordination (Diff=21.50, t(43)=3.36, p=0.002; Cohen’s d=1.00: large effect size). The results therefore indicate that the integrated movement programme could have potentially had a positive effect on motor coordination in the experimental group.
4.5 RESULTS FOR SCHOLASTIC ACHIEVEMENT

Scholastic achievement in the context of this study was defined as how well a participant performed within three specific domains of primary schooling. These domains were numeracy, reading, writing and a total domain representing the average between these three domains was calculated to indicate overall scholastic achievement. The tables 12, 13, 14, and 15 below represent the average scores in each of the domains for the experimental- and control group over each testing periods. Table 12 below illustrates the descriptive and inferential statistics for the numeracy domain of scholastic achievement indicating the comparative differences between the experimental- and control group.

Table 12: t-Tests for scholastic numeracy score comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen's d</th>
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<tbody>
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<td>Exp Grp</td>
<td>21</td>
<td>5,57</td>
<td>±0,51</td>
<td>0,45</td>
<td>1,74</td>
<td>43</td>
<td>,089</td>
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<td>5,13</td>
<td>±1,08</td>
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<td>5,52</td>
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<td>1,58</td>
<td>43</td>
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<td>Acad N Pre2</td>
<td>Exp Grp</td>
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<td>5,52</td>
<td>±0,60</td>
<td>0,36</td>
<td>1,58</td>
<td>43</td>
<td>,121</td>
<td>not applicable</td>
</tr>
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<td>5,17</td>
<td>±0,87</td>
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</tr>
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<td>Acad N Post2</td>
<td>Exp Grp</td>
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<td>±0,60</td>
<td>0,24</td>
<td>0,92</td>
<td>43</td>
<td>,364</td>
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<td>±1,05</td>
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<td>Exp Grp</td>
<td>21</td>
<td>-0,05</td>
<td>±0,38</td>
<td>-0,09</td>
<td>-0,53</td>
<td>43</td>
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<td>0,00</td>
<td>±0,00</td>
<td>0,00</td>
<td>0</td>
<td>43</td>
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<td>±0,00</td>
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<td>±0,59</td>
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</tbody>
</table>
The results indicate that there was no significant initial difference between numeracy score averages between the two groups (p=0.89; Cohen’s d not applicable). Over the first intervention period there was an average decrease in numeracy of 0.05±0.38 in the experimental group and an average increase of 0.04±0.69 in the control group over the first intervention period. Over the second intervention period there was an average increase of 0.05±0.22 in the experimental group and an average increase of 0.17±0.64 in the control group. Over the duration of the study the experimental group experienced no change in numeracy scores, and the control group experienced a total increase of 0.21±0.59 (Diff=-0.21, t(43)=-1.32, p=0.193; Cohen’s d=not applicable). The results indicate that there were no significant changes in numeracy scores over the duration of the study for both the experimental- and control group.

Table 13 on the following page illustrates the descriptive and inferential statistics for the reading domain of scholastic achievement indicating the comparative differences between the experimental- and control group.
Table 13: t-Tests for scholastic reading score comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen's d</th>
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<td>±0.80</td>
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<td>±0.74</td>
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<td>Exp Grp</td>
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<td>5.57</td>
<td>±0.81</td>
<td>1.24</td>
<td>5.49</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.33</td>
<td>±0.70</td>
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<td>±0.70</td>
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<td>Large</td>
</tr>
<tr>
<td>Acad R Post2</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.43</td>
<td>±0.93</td>
<td>0.80</td>
<td>2.99</td>
<td>43</td>
<td>&lt;.005</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.63</td>
<td>±0.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Acad R Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.10</td>
<td>±0.44</td>
<td>-0.30</td>
<td>-2.39</td>
<td>43</td>
<td>&lt;.021</td>
<td>0.71</td>
</tr>
<tr>
<td>Post1-Pre1</td>
<td>Control Grp</td>
<td>24</td>
<td>0.21</td>
<td>±0.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Acad R Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>0.00</td>
<td>±0.00</td>
<td>0.00</td>
<td>0</td>
<td>43</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pre2-Post1</td>
<td>Control Grp</td>
<td>24</td>
<td>0.00</td>
<td>±0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Acad R Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.14</td>
<td>±0.36</td>
<td>-0.43</td>
<td>-3.09</td>
<td>43</td>
<td>&lt;.004</td>
<td>0.92</td>
</tr>
<tr>
<td>Post2-Pre2</td>
<td>Control Grp</td>
<td>24</td>
<td>0.29</td>
<td>±0.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Acad R Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.24</td>
<td>±0.44</td>
<td>-0.74</td>
<td>-4.71</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.41</td>
</tr>
<tr>
<td>Post2-Pre1</td>
<td>Control Grp</td>
<td>24</td>
<td>0.50</td>
<td>±0.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
</tbody>
</table>
The results indicate that there was a significant initial between-group difference in reading score averages (Diff=1.54, t(43)=6.73, p<0.0005; Cohen’s d=2.01: large effect size). Over the first intervention period there was an average decrease in reading of 0.10±0.44 in the experimental group and an average increase of 0.21±0.41 in the control group (Diff=-0.30, t(43)=-2.39, p=0.021; Cohen’s d=0.71: medium effect size). Over the second intervention period there was an average decrease of 0.14±0.36 in the experimental group and an average increase of 0.29±0.55 in the control group. Over the duration of the study the experimental group experienced a total decrease of 0.24±0.44 and the control group a total increase of 0.50±0.59 in reading mean values (Diff=-0.74, t(43)=-4.71, p<0.0005; Cohen’s d=1.41: large effect size). The results indicate that there was a significant increase in reading of the control group (p<0.05).
Table 14 below reports on the descriptive and inferential statistics for the writing domain of scholastic achievement indicating the comparative differences between the experimental- and control group.

**Table 14: t-Tests for scholastic writing score comparisons between the experimental- and control group**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acad W Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.62</td>
<td>±0.74</td>
<td>1.79</td>
<td>6.90</td>
<td>43</td>
<td>&lt;.0005</td>
<td>2.06</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>3.83</td>
<td>±0.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Acad W Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.62</td>
<td>±0.67</td>
<td>1.33</td>
<td>4.73</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.29</td>
<td>±1.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Acad W Pre2</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.62</td>
<td>±0.67</td>
<td>1.33</td>
<td>4.73</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.29</td>
<td>±1.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Acad W Post2</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.05</td>
<td>±0.86</td>
<td>0.84</td>
<td>2.53</td>
<td>43</td>
<td>.015</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.21</td>
<td>±1.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Acad W Diff Post1-Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>0.00</td>
<td>±0.71</td>
<td>-0.46</td>
<td>-2.25</td>
<td>43</td>
<td>.030</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>0.46</td>
<td>±0.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Acad W Diff Pre2-Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>0.00</td>
<td>±0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>43</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>0.00</td>
<td>±0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Acad W Diff Post2-Pre2</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.57</td>
<td>±0.68</td>
<td>-0.49</td>
<td>-2.34</td>
<td>43</td>
<td>.024</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>-0.08</td>
<td>±0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Acad W Diff Post2-Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.57</td>
<td>±0.98</td>
<td>-0.95</td>
<td>-3.63</td>
<td>43</td>
<td>.001</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>0.38</td>
<td>±0.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large</td>
</tr>
</tbody>
</table>
The results indicate that there was a significant initial between-group difference in writing score averages (Diff=1.79, t(43)=6.90, p<0.0005; Cohen’s d=2.06: large effect size). Over the first intervention period there was no change in reading scores for the experimental group and an average increase of 0.46±0.66 in the control group (Diff=-0.46, t(43)=-2.25, p=0.030; Cohen’s d=0.67: medium effect size). Over the second intervention period there was an average decrease of 0.57±0.68 in the experimental group and an average decrease of 0.08±0.72 in the control group. Over the duration of the study the experimental group experienced a total decrease of 0.57±0.98 and the control group a total increase of 0.38±0.77 in writing mean values (Diff=-0.95, t(43)=-3.63, p=0.001; Cohen’s d=1.08: large effect size). The results indicate that the experimental group had a higher average post-intervention score for writing (M=5.05±0.86), but there was a significant increase in writing scores of the control group over the duration of the study (p<0.05).
Table 15 below reports on the descriptive and inferential statistics for the total domain of scholastic achievement, which was based on the average of the numeracy, reading and writing domain scores of each participant for the experimental- and control group. This table reflects the baseline and post-test results from before and after the study intervention.

Table 15: t-Tests for total scholastic score comparisons between the experimental- and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>±S.D</th>
<th>Diff</th>
<th>t</th>
<th>d.f.</th>
<th>p(d.f.=43)</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acad T Pre1</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.62</td>
<td>±0.51</td>
<td>1.26</td>
<td>6.42</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.36</td>
<td>±0.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Post1</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.57</td>
<td>±0.54</td>
<td>0.97</td>
<td>5.07</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.51</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.60</td>
<td>±0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Pre2</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.57</td>
<td>±0.54</td>
<td>0.97</td>
<td>5.07</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.51</td>
</tr>
<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.60</td>
<td>±0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Post2</td>
<td>Exp Grp</td>
<td>21</td>
<td>5.35</td>
<td>±0.66</td>
<td>0.63</td>
<td>2.61</td>
<td>43</td>
<td>.012</td>
<td>0.78</td>
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<tr>
<td></td>
<td>Control Grp</td>
<td>24</td>
<td>4.72</td>
<td>±0.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.05</td>
<td>±0.28</td>
<td>-0.28</td>
<td>-2.97</td>
<td>43</td>
<td>.005</td>
<td>0.89</td>
</tr>
<tr>
<td>Post1-Pre1</td>
<td>Control Grp</td>
<td>24</td>
<td>0.24</td>
<td>±0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>0.00</td>
<td>±0.00</td>
<td>0.00</td>
<td>0</td>
<td>43</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pre2-Post1</td>
<td>Control Grp</td>
<td>24</td>
<td>0.00</td>
<td>±0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.22</td>
<td>±0.32</td>
<td>-0.35</td>
<td>-2.94</td>
<td>43</td>
<td>.005</td>
<td>0.88</td>
</tr>
<tr>
<td>Post2-Pre2</td>
<td>Control Grp</td>
<td>24</td>
<td>0.13</td>
<td>±0.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acad T Diff</td>
<td>Exp Grp</td>
<td>21</td>
<td>-0.27</td>
<td>±0.43</td>
<td>-0.63</td>
<td>-5.23</td>
<td>43</td>
<td>&lt;.0005</td>
<td>1.56</td>
</tr>
<tr>
<td>Post2-Pre1</td>
<td>Control Grp</td>
<td>24</td>
<td>0.36</td>
<td>±0.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results indicate that there was a significant initial between-group difference in total average scholastic achievement (Diff=1.26, t(43)=6.42, p<0.0005; Cohen’s d=1.92: large effect size). Over the first intervention period there was a decrease of 0.05±0.28 in total scholastic achievement scores for the experimental group and an average increase of 0.24±0.35 in the control group (Diff=-0.28, t(43)=-2.97, p=0.005; Cohen’s d=0.89: large effect size). Over the second intervention period there was an average decrease of 0.22±0.32 in the experimental group and an average increase of 0.13±0.45 in the control group. Over the duration of the study the experimental group experienced a total decrease of 0.27±0.43 and the control group a total increase of 0.36±0.38 in average scholastic achievement values (Diff=-0.63, t(43)=-5.23, p<0.0005; Cohen’s d=1.56: large effect size). The results indicate that the experimental group had a higher average post-intervention score for average total scholastic achievement (M=5.35±0.66), but there was a significant increase in average scores for the control group over the duration of the study (p<0.05). This therefore indicates that the integrated movement programme did not have a significant positive effect on total scholastic achievement over the duration of the study.
4.6 RELATIONSHIPS BETWEEN MOTOR PROFICIENCY, VISUAL-MOTOR INTEGRATION AND SCHOLASTIC ACHIEVEMENT

Correlational statistics involve a type of non-experimental analysis that allows the description of the relationship between two measured variables. Correlations allow predictions to be made from one variable to another within a certain degree of accuracy (Jackson, 2015:149). Pearson Product Moment correlation, which is a measure of linear dependence between two variables, was used for this study. Below are tables representing the correlation between motor proficiency, visual-motor integration (with subsets of visual perception and motor coordination) and scholastic achievement (with subsets of reading, writing and numeracy) in order to identify the relationship and magnitude of associations between these variables share with one another.

Table 16 indicates the ranges and magnitude of associations for description of correlations of the results to follow.

**Table 16: Interpretation of significance of correlations**

<table>
<thead>
<tr>
<th>Correlations are:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistically significant at $p=0.05$ for $n=21$ if $</td>
</tr>
<tr>
<td>Practically significant if $</td>
</tr>
<tr>
<td>Statistically and practically significant if $</td>
</tr>
</tbody>
</table>

(Gravetter & Wallnau, 2009:534)

<table>
<thead>
<tr>
<th>Key</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acad</td>
<td>Scholastic achievement</td>
</tr>
<tr>
<td>MP</td>
<td>Motor Proficiency</td>
</tr>
<tr>
<td>VMI</td>
<td>Visual-motor Integration</td>
</tr>
<tr>
<td>VP</td>
<td>Visual Perception</td>
</tr>
<tr>
<td>MC</td>
<td>Motor Coordination</td>
</tr>
<tr>
<td>n</td>
<td>Total number of participants</td>
</tr>
<tr>
<td>N</td>
<td>Numeracy</td>
</tr>
<tr>
<td>R</td>
<td>Reading</td>
</tr>
<tr>
<td>W</td>
<td>Writing</td>
</tr>
<tr>
<td>T</td>
<td>Total Scholastic Achievement</td>
</tr>
</tbody>
</table>
Table 17 below reports on whether any relationships existed between the dependant variables motor proficiency, visual-motor integration, visual perception, motor coordination or any of the scholastic achievement domains at the initial baseline pre-test.

Table 17: Pre-test 1 correlations for motor proficiency, visual-motor integration, and scholastic achievement in the experimental- and control group

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group (n = 21)</th>
<th>Control Group (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acad R</td>
<td>Acad W</td>
</tr>
<tr>
<td>MP Percentile</td>
<td>-.137</td>
<td>.015</td>
</tr>
<tr>
<td>VMI Percentile</td>
<td>-.057</td>
<td>-.326</td>
</tr>
<tr>
<td>VP Percentile</td>
<td>.064</td>
<td>.307</td>
</tr>
<tr>
<td>MC Percentile</td>
<td>-.034</td>
<td>-.240</td>
</tr>
</tbody>
</table>

Key

Acad: Scholastic achievement
MP: Motor Proficiency
VMI: Visual-motor Integration
VP: Visual Perception
MC: Motor Coordination
n: Total number of participants
N: Numeracy
R: Reading
W: Writing
T: Total Scholastic Achievement

The baseline results indicate that there were only practically significant relationships between two of the dependant variables in the experimental group. A weak negative relationship existed between visual-motor integration and writing \( |r| = -0.326 \) and a weak positive relationship between visual perception and writing \( |r| = 0.307 \) at \( p<0.05 \).

The control group results indicate a statistically and practically significant positive, moderate relationship between visual perception and writing \( |r| = 0.504 \); and between motor coordination and academic writing \( |r| = 0.532 \) at the pre-test assessment at
Furthermore, practically significant weak positive relationships were found between motor proficiency and writing \(|r|=0.388\); between motor coordination and numeracy \(|r|=0.327\); between motor coordination and total scholastic achievement \(|r|=0.367\); and visual perception and total scholastic achievement \(|r|=0.311\) at \((p<0.05)\).

Table 18 below reports on whether any relationships existed between the dependant variables motor proficiency, visual-motor integration, visual perception, motor coordination or any of the scholastic achievement domains at the initial baseline post-test.

Table 18: Post-test 1 correlations for motor proficiency, visual-motor integration and scholastic achievement in the experimental- and control group

<table>
<thead>
<tr>
<th>Key</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acad</td>
<td>Scholastic achievement</td>
</tr>
<tr>
<td>MP</td>
<td>Motor Proficiency</td>
</tr>
<tr>
<td>VMI</td>
<td>Visual-motor Integration</td>
</tr>
<tr>
<td>VP</td>
<td>Visual Perception</td>
</tr>
<tr>
<td>MC</td>
<td>Motor Coordination</td>
</tr>
<tr>
<td>n</td>
<td>Total number of participants</td>
</tr>
<tr>
<td>N</td>
<td>Numeracy</td>
</tr>
<tr>
<td>R</td>
<td>Reading</td>
</tr>
<tr>
<td>W</td>
<td>Writing</td>
</tr>
<tr>
<td>T</td>
<td>Total Scholastic Achievement</td>
</tr>
</tbody>
</table>
The results after the first intervention period indicate that there was a statistically and practically significant weak negative relationship between visual-motor integration and writing in the experimental group \(|r|=-0.451\) at (\(p<0.05\)). Practically weak positive relationships were found between visual-motor integration and numeracy \(|r|=0.301\); visual perception and writing \(|r|=0.314\), as well as motor coordination and numeracy \(|r|=0.377\) at (\(p<0.05\)).

Table 19 below reports on whether any relationships existed between the dependant variables motor proficiency, visual-motor integration, visual perception, motor coordination or any of the scholastic achievement domains after the first intervention in school term three and prior to the second intervention in the fourth term at the second pre-test.

**Table 19: Pre-test 2 correlations for motor proficiency, visual-motor integration, and scholastic achievement in the experimental- and control group**

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group (n = 21)</th>
<th>Control Group (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acad R</td>
<td>Acad W</td>
</tr>
<tr>
<td><strong>MP Percentile</strong></td>
<td>-.072</td>
<td>.214</td>
</tr>
<tr>
<td><strong>VMI Percentile</strong></td>
<td>.261</td>
<td>-.106</td>
</tr>
<tr>
<td><strong>VP Percentile</strong></td>
<td>.198</td>
<td>.222</td>
</tr>
<tr>
<td><strong>MC Percentile</strong></td>
<td>-.332</td>
<td>.208</td>
</tr>
</tbody>
</table>

**Key**
- Acad: Scholastic achievement
- MP: Motor Proficiency
- VMI: Visual-motor Integration
- VP: Visual Perception
- MC: Motor Coordination
- n: Total number of participants
- N: Numeracy
- R: Reading
- W: Writing
- T: Total Scholastic Achievement
The results at the start of the second intervention period indicate that there was a practically significant weak negative correlation between motor coordination and reading \(|r|=-0.332\); and between motor coordination and numeracy \(|r|=-0.332\) in the experimental group at \((p<0.05)\). There were practically significant weak, positive relationships between visual-motor integration and writing \(|r|=0.306\); and between motor coordination and numeracy \(|r|=0.313\) at \((p<0.05)\).

Table 20 below reports on whether any relationships existed between the dependant variables motor proficiency, visual-motor integration, visual perception, motor coordination or any of the scholastic achievement domains at the final post-test.

Table 20: Post-test 2 correlations for motor proficiency, visual-motor integration, and scholastic achievement in the experimental- and control group

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group (n = 21)</th>
<th>Control Group (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acad R</td>
<td>Acad W</td>
</tr>
<tr>
<td>MP Percentile</td>
<td>-.171</td>
<td>.091</td>
</tr>
<tr>
<td>VMI Percentile</td>
<td>.350</td>
<td>.220</td>
</tr>
<tr>
<td>VP Percentile</td>
<td>.023</td>
<td>.336</td>
</tr>
<tr>
<td>MC Percentile</td>
<td>.143</td>
<td>.318</td>
</tr>
</tbody>
</table>

**Key**

- Acad: Scholastic achievement
- MP: Motor Proficiency
- VMI: Visual-motor Integration
- VP: Visual Perception
- MC: Motor Coordination
- n: Total number of participants
- N: Numeracy
- R: Reading
- W: Writing
- T: Total Scholastic Achievement
The results after the second intervention for the experimental group indicated practically significant weak positive relationships between visual-motor integration and reading $|r|=0.350$; visual-motor integration and total scholastic achievement $|r|=0.330$; visual perception and writing $|r|=0.336$; and motor coordination and writing $|r|=0.318$ at (p<0.05). Results for the control group indicated a practically significant weak negative correlation between visual perception and reading $|r|=-0.304$; and practically weak positive relationships between visual perception and writing $|r|=0.319$; motor coordination and writing $|r|=0.340$; motor coordination and numeracy $|r|=0.378$; and motor coordination and total scholastic achievement $|r|=0.378$ at (p<0.05).

4.7 SUMMARY

Chapter 4 highlighted the descriptive, inferential and correlational statistical analysis of results obtained to answer the research question and objectives stated in chapter 1. The experimental group had significantly higher initial mean values for motor proficiency and visual-motor integration (and subsets of visual perception and motor coordination). The experimental group also had higher initial averages for the reading, writing, numeracy and overall domains of scholastic achievement in comparison to the control group.

The experimental group showed improvement in motor proficiency post-intervention. Both the experimental- and control groups showed decreased visual-motor integration post-intervention. Both the experimental- and control groups experienced statistically significant increases in visual perception after the entire intervention period.

The experimental group experienced a significant improvement in motor coordination and visual perception, whilst the control group decreased in motor coordination over the total duration of the intervention. There was no significant improvement in the
scholastic achievement domains during the intervention periods for the experimental-
nor control group.

Post-intervention positive practical significance at (p<0.05) was found between visual-
motor integration and reading; visual perception and writing; motor coordination and
writing; visual-motor integration and total scholastic achievement in the experimental
group. In the control group positive practical significance at (p<0.05) was found
between visual perception and writing; motor coordination and numeracy; motor
coordination and total scholastic achievement; and negative practical significance was
evident between visual perception and reading at (p<0.05) after the intervention
period.
5. CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Kinderkinetics is an increasingly growing field of study that has been previously explored with relations to developmental processes but as stated in chapter 1, still lacks empirical research on the effects of certain intervention programmes on motor proficiency, visual-motor integration and cognitive abilities (Malina, Bouchard, & Bar-Or, 2004: 3-14; Rowland, 2005: 474-478; Tomporowski et al., 2011:S4; Nalder & Northcote, 2015:1-11). Studies have been conducted to assess the relationship between visual-motor integration, motor proficiency and literacy in numeracy, reading and writing and indicate that positive relationships do exist (Tomporowski et al., 2011:5; Pienaar et al., 2014:371; Nalder & Northcote, 2015:1-11). As described in chapter 1, correlation statistics have also been done on large samples of adolescents and children, which indicate that there are moderate to strong positive correlations between taking part in physical education, the quantity of activity and scholastic achievement as well as behaviour in the school environment (Carlson, Fulton, & Lee, 2008: 721-727; Roberts, Freed, & McCarthy, 2010;711-718; Nalder & Northcote, 2015:1-11). Most literature found, was conducted within developed countries and highlighted the lack of research on the effects of the aforementioned variables in children of developing countries. The results of this study therefore aim to highlight potential effects of a specifically designed integrated movement intervention programme on children’s motor proficiency, visual-motor integration, and scholastic achievement in a developing country such as South Africa.
5.2 AGE AND GENDER RELATED CHANGES

As stated in chapter 2, there are no fixed ages at which specific acquisition of motor skills occur, but rather ranges in which there is potential for development to occur during developmental stages in children (Jedynak, 2009:64-76; Gallahue et al., 2012:49). This variable developmental rate can therefore have adverse effects on the rate of motor-, perceptual- and cognitive development of children and thus lead to stages of readiness instead of specific ages of readiness (Piek, 2006:156-165). Literature indicates that boys and girls undergo similar adaptations in fundamental movement skills during early childhood and only begin to significantly differentiate in skill and capabilities when reaching puberty (Peens & Pienaar, 2007:113-128; Venetsanou & Kambas, 2016:14-20). As can be seen in Figure 1, Adaptation of training and optimal trainability in section 2.5.4 of chapter 2, children go through different changes in the acquisition of speed, velocity, motor coordination, physical literacy and certain skills and therefore can undergo significant changes over an intervention period which can affect total outcome scores (Balyi & Hamilton, 2004:7; Jedynak, 2009:64-76; Gallahue et al., 2012:4).

Table 3 in chapter 4 represents the pre- and post-test ages of both the experimental- and control participants over the two intervention periods. The results indicated that there was no significant difference in ages between the two groups and all participants were aged between six and seven years. According to Balyi and Hamilton (2004:3) children from the ages of six to seven are within the mature stage of fundamental movement skill development, therefore the age changes that occurred during the intervention period can be viewed as not being a contributing factor to the results obtained as all participants were within this age range for this study. Table 4 in chapter 4 represents the gender ratios of boys to girls in both groups and indicates that these ratios were almost identical. Thus, gender had no influence on the results obtained and conclusions made could not be based on gender differences.
5.3 MOTOR PROFICIENCY

Motor proficiency is the development of complex movement patterns and motor control that allows a person to perform complex motor skills by using fine and gross-motor skills (Liu, Hamilton & Smith, 2015:1-4). Optimal central processing in the brain and coordination with higher executive functioning allows for movements to flow and be targeted and accurate within each movement context (Pienaar et al., 2014:371). The BOT-2 Brief Form test battery was used to test motor proficiency for the study.

The results seen in Table 5 of chapter 4 indicate that there were significant initial and final between-group differences in motor proficiency. The experimental- and control groups both experienced increases in motor proficiency over the duration of the study, but the experimental group experienced a larger average increase. This signifies that both groups improved proficiency in terms of running speed and agility, balance, bilateral coordination, strength, upper-limb coordination, response speed, visual-motor control, upper-limb speed and dexterity skills as subsets of motor proficiency as explained previously in chapter 2 (Tecklin, 2008:75-89). NeuroNet is aimed at improving reading, decoding, handwriting, and mathematical fact retrieval through the facilitation by movement-based learning exercises that allow the integration of rhythm, listening, speaking and workbook-based exercises to improve handwriting (NeuroNet learning, 2016). Through the use of such activities NeuroNet allows children to develop their motor proficiency by focusing on the development of gross and fine-motor skills, thus could have had positive effects on the children’s motor proficiencies. Thus, the significant improvement in motor proficiency of the experimental group could potentially have been due to the integrated movement programme.

Generally children mature in motor ability as they age chronologically and learn to master more complex skills and tasks as they mature cognitively (Pieke, 2006:156-165; Kokštejn et al., 2017:1-10). Therefore the improvements in motor proficiency of both groups could have been due to maturational adaptations that occur with advances in
chronological age during the schooling year. As described in chapter 2, there is no fixed rate of development as all children grow at individual rates having adverse effects on motor, cognitive and perceptual development. The hourglass model displayed in figure 1 section 2.5.4 of chapter 2 illustrates stages of readiness where chronological ages are grouped in order to explain equivocal developmental periods instead of defined ages at which development occurs. Thus, the experimental group could have potentially reached their pinnacle of motor proficiency development before the control group and therefore showed more advanced motor proficiency over the duration of the study.

Other reasoning for improvements in motor proficiency could be that the content of the curriculum at school in term three and four was stimulating enough to cause an increase in motor skill proficiency for both groups. Also, the change over from participation in winter sports in term three to summer sports in term four, could have stimulated changes in motor neural pathways, making motor skill acquisition easier and resulting in higher motor proficiency scores in the test battery results reflecting as improvements in average motor proficiency.

5.4 VISUAL-MOTOR INTEGRATION

Visual-motor integration refers to one’s ability to coordinate visual perception and motor output with regards to finger-hand movements (Pienaar et al., 2014:371). The Beery VMI test battery was used to test visual-motor integration within the study.

The results in Table 9 of chapter 4 indicate that in school term three the experimental group underwent an improvement in visual-motor integration whereas the control group decreased in proficiency levels for visual-motor integration. In school term four both groups decreased in visual-motor integration. The results obtained could potentially be ascribed to the fact that the children from the control group reached a
plateau in visual-motor integration after the second school term, and the children from the experimental group reaching this plateau in the third school term, therefore indicating that no significant improvements in visual-motor integration occurred during the fourth schooling term. This finding is congruent with research done by Julius and co-authors (2016:265-272) indicating that children tend to reach a plateau in visual-motor integration skills towards the latter end of grade one before transitioning into motor skill automaticity by grade three.

Another possible reason could be that the children reached their optimal visual-motor integration development in the second and third term when most children had reached the age of seven (upper end of the mature stage of the hourglass model before moving into the specialised movement stage), therefore showing no significant improvement in the fourth term. Extraneous variables such as teaching content, not being stimulating or challenging enough, inconsistent testing times for visual-motor integration, or distractions within the schooling environment also could have potentially affected the findings.

5.4.1 Visual Perception

Visual perception is the use of cognitive skills to extract and organise visual information from the environment and allowing the integration of this perceived information with sensory modalities, past experiences and higher cognitive functions (Pienaar et al., 2014:371).

The results in Table 10 of chapter 4 therefore indicate that both the experimental- and control groups experienced an improvement in visual perception over the duration of the two intervention periods, and the experimental group had better visual perception ratings from the start of the study. Since NeuroNet is aimed at improving reading decoding, handwriting, and mathematical fact retrieval through the use of movement-
based learning exercises that allow the integration of rhythm, listening, speaking and workbook-based exercises to improve handwriting (NeuroNet learning, 2016), the increase in the experimental group could have been due to the integrated movement programme. The movement programme could have improved the children’s abilities to extract and organise information from the environment to allow the integration of this perceived information with sensory modalities, past experiences and higher cognitive functions (Pienaar et al., 2014:371). Ultimately this could have led to the children having better visual perception and performing better on the tests. The control group could have had a well-structured physical education programme implemented by a competent teacher which could have also allowed these aforementioned adaptions to occur and also contribute to improvements of visual perception over the duration of the study.

Other explanations for the increase in visual perception could have been due to the learning effect where the participants became familiar with the test protocol in the post-tests and therefore knew what was expected of them. The researcher could argue that the occurrence of the learning effect could have had adverse effects on the validity and reliability of the study due to the challenge of ascribing the findings solely to the intervention.

5.4.2 Motor Coordination

According to Venetsanou and Kambas (2016:14-20) motor coordination is the study of neural, behavioural, environmental, and synergistic mechanisms used for movement and stability in humans.

The results on motor coordination in Table 11 of chapter 4 indicate that the control group initially had a higher proficiency in motor coordination and decreased in proficiency over the study, whereas the experimental group improved significantly in
motor coordination over the duration of the study. This significant improvement in the experimental group could have been due to the implementation of the integrated movement programme which allowed the children to continually practice motor coordination skills and potentially better retention thereof.

According to research, children naturally improve in motor skills as they mature and are stimulated in the correct movements, therefore the teaching environment could have been adequately stimulating for the experimental group, which enhanced improvements in motor coordination over the two scholastic terms (Riethmuller, 2011:11-51; Gallahue et al., 2012:46-55). Other contributing factors include; physical characteristics of the children such as a learners’ strength, balance, body size and brain development which could have positively influenced the experimental groups’ average motor coordination, if the children were more developed physically at the time of testing compared to the control group (Newell, 1986:347-353; Leonard & Hill, 2015:1-14; Ackerman et al., 2017:1-15).

5.5 SCHOLASTIC ACHIEVEMENT

Scholastic achievement refers to a learner’s success in meeting short- or long-term goals in education according to certain criteria developed by government (Chakrabarti, 2008:77-78). The Department of Basic Education for South Africa has created a standard rating table containing up to seven rating codes with associated achievement descriptions and mark percentages, as can be seen in Table 1 in section 3.6.3 (Department of Basic Education, 2011). Scholastic achievement was graded by the experimental- and control group grade one teachers and therefore the assumption is made that subjective ratings were used to obtain scholastic achievement scores for numeracy, reading, writing and total achievement.
A study done by Pienaar and colleagues (2014:373-374) concludes that results obtained for visual-motor integration and visual perception are highly significant for mastery in numeracy, reading and writing, therefore showing a strong relationship between scholastic performance in basic learning areas in grade one learners and visual-motor integration, visual perception, finger-hand motor coordination and overall motor proficiency. The above-mentioned study in conjunction with multiple Kinderkinetics-related studies agree that some form of positive relationship is evident between motor development and cognitive abilities (Carlson, Fulton, & Lee, 2008: 721-727; Roberts, Freed, & McCarthy, 2010:711-718; Tomporowski et al., 2011:S5).

According to the results for the scholastic achievement domain displayed in chapter 4 there was no significant change in numeracy scores for both groups after each intervention period, but the experimental group had higher average initial reading scores. The experimental group underwent a decrease in average reading, writing and total scholastic achievement scores over the study period, whereas the control group improved in these domains. The results for the control group could have been due to chronological improvements in cognition allowing better performances in academic work. The work done in schooling terms three and four could have been adequately stimulating, hence producing improvements in scholastic cognition and therefore academic outcomes. The teacher could have taught appropriately stimulating content and administered the work in a way that the children found easy to learn, hence improving in the scholastic domains.

Other reasons for the enhanced visual-motor integration in both groups, could be due to the fact that the control school had a well-structured physical education system with a dedicated and motivated teacher, who maximised developmental opportunities for the children. Although the experimental group experienced decreases in the reading, writing and total scholastic achievement domains, the average scores for these domains were still significantly higher than that of the control group post-intervention.
As expressed in chapter 2, motor proficiency aids development of motor control and can be used as an index of a child’s motor development (Bruininks & Bruininks, 2010:12; Venetsanou & Kambas, 2016:14-20). Motor proficiency is influenced by a variety of factors including nourishment, health, safety, opportunity, practice, encouragement and instruction, recreational activities and physical education in schools, family features such as socioeconomic status, mother’s educational level and number of siblings (Gordon & Browne, 2010:373; Venetsanou & Kambas, 2010:319-327; Horn, 2015:29-32). If motor proficiency is not adequately developed, the incompetency may jeopardise future participation in physical activity and may lead to motor deficiencies as well as learning deficits and can negatively impact scholastic achievement (Goodway et al., 2003:298-314; Riethmuller et al., 2009:e782-e783; Pienaar et al., 2014:370-371).

As can be seen in section 5.3 and 5.4.2 above, the experimental group had more advanced motor proficiency at baseline and higher scholastic achievement scores before and after the study regardless of the decreases. Therefore this finding can add to the notion that improved motor proficiency has positive influences on scholastic achievement. Adequate development of visual perception in terms of sensory processing, visual attention, visual discrimination, visual memory, visual-spatial relationships, visual sequential memory, figure ground, visual form constancy, and visual closure, allows a child to comprehend a task at hand (Schwartz, 2004; Pienaar et al., 2014:371). This correspondingly has positive effects on a child’s academic performance, attention and concentration, self-regulation, behaviour, frustration levels, organisation skills and they may tend to avoid tasks involving visual perception completely (Schwartz, 2004; Van Dantzig et al., 2008:579-590; Dhingra et al., 2010:143-147). As can be seen in section 5.4.1 above, the experimental group had more advanced visual perception and higher scholastic achievement scores before and after the study, thus indicating that better visual perception could have positively influenced the scholastic performance of the experimental group.
The experimental group was exposed to the movement programme in the first schooling term of the year of testing as well as in grade R, and therefore the children could have already made adaptations and improvements in scholastic performances before the testing occurred in the second school term, hence indicating no improvements in scholastic achievement over the entire intervention period.

5.6 CONCLUSION

Many international and local studies propose that various aspects of a child’s development can be impeded if they have poor motor proficiency due to the positive relationship evident between visual-motor integration, perceptual-motor development and motor proficiency and literacy in numeracy (mathematics), reading and writing. Good motor ability is thought to serve as a buffer for the challenges and demands placed on a child during the transition to formal schooling environments as with grade ones. Researchers argue that motor proficiency is associated with improved scholastic adaptation and increased social behaviours, whereas poor motor ability makes a child susceptible to negative impacts during these transitional periods. There are many controversial studies debating whether movement programmes have any impact on scholastic achievement and cognitive development of adolescents. Recent literature resources tend to propagate the concept of physical activity having a positive influence on scholastic performance.

In summary, the experimental group showed a 24% improvement in motor proficiency with the control group obtaining only an 8% improvement. The results indicated that the experimental group had better visual perception and higher initial and final scholastic achievement domain scores when compared to the control group. The two groups had similar visual-motor integration and motor coordination baseline proficiencies, with the experimental group having experienced a significant
improvement in average motor coordination compared to the control group post-intervention. The integrated movement programme could potentially have been the reason for these significant effects in participants of the experimental group.

The statistical comparison between motor proficiency, visual-motor integration, visual perception, motor coordination and scholastic achievement domains of the study showed a positive relationship between visual-motor integration, visual perception and motor coordination and literacy in reading, writing and total scholastic achievement. Therefore the findings of this study are in agreement with previously mentioned studies. Overall, there was a weak correlation between the motor proficiency and any of the four scholastic achievement domains, except for writing. Thus indicating that within this study, fine and gross-motor proficiency is not significantly related to a child’s scholastic achievement, but does have an influence on the writing abilities of children.

5.7 LIMITATIONS

Literature-based limitations of evidence-based studies include the exclusion of accounting for the difference in ethnic groups as most South African schools are multi-ethnic and vary in their socioeconomic circumstances such as the disparity between quintile one and quintile five schools (Coetzee & Du Plessis, 2013:46-47; Visagie, Coetzee & Pienaar, 2017:199-217). Other limitations include the fact that the BOT-2 Brief Form only assesses certain aspects of motor proficiency instead of providing a comprehensive report on all motor development and skill components. Most test batteries do not accommodate for physically disabled children or children with certain health and psychosocial constraints, which limit a child’s motor development and progress in scholastic performance and can therefore influence motor proficiency, visual-motor integration, and scholastic achievement (Tomporowski et al., 2011:58; Coetzee & Du Plessis, 2013:46-47; Coetzee & Kemp, 2015:37-38). There is a general lack of integrated movement programme research, not only in South Africa, but
globally, as well as a lack of variation in availability in test battery selection (Du Plessis, Coetzee, & Pienaar, 2015:79).

One of the limitations of the study was the use of a quasi-experimental design as the use of this methodological design prevents complete randomisation of the study sample. Furthermore, convenience sampling did not allow for generalisability of findings, as the targeted sample population was not representative of all grade one children in all primary schools in South Africa. Findings however, could provide a platform to springboard further research of longitudinal nature in stratified random sample selection of participants. The experimental- and control groups did not have equal baseline data, this therefore prevented the results from being a true reflection of the effects of the integrated movement programme.

Specific limitations encountered by the researcher within the reported study included the fact that the schools were not willing to provide large amounts of time for extensive testing to be done. Some children were absent during the pre- or post-test assessments which limited the number of participants available for testing and subsequent data for statistical interpretation. Different research assistants helped throughout the testing period which could have affected the inter-rater reliability. The school teachers graded the reports for the relevant classes and this therefore could have affected the overall consistency, reliability and validity of the scholastic achievement results reported in the study. Some participants were tested after break times after they had eaten which could have affected the participant’s energy levels as well as concentration spans, therefore affecting the final performance outcomes. The learning effect was also a limitation as participants could have become familiar with each test once previously performed, therefore preventing the conclusion that the changes present were due solely to the intervention programme. Other extraneous variables such as family environments, sleep patterns, stimulant consumption and different schooling environments in terms of teacher assistance and peer stimulation.
could have also been limitations within the study as these factors are not controllable from a researcher’s perspective.

5.8 RECOMMENDATIONS FOR FUTURE RESEARCH

According to the literature-based limitations, it is recommended that future studies be longitudinal in nature, extending as long as possible to make valid and reliable conclusions about the actual effects of an intervention. It is also suggested to investigate and compare a variety of strata such as different ethnic groups, gender differences as well as comparisons of children from different socio-economic backgrounds (Coetzee & Du Plessis, 2013:46-47). According to Coetzee and Du Plessis (2013:46-47) the first two years of formal schooling are significantly important as this is when optimal visual-motor skills are beneficial for scholastic and motoric development. This is also the time when early detection of deficits in visual-motor integration, visual perception and motor coordination becomes important to allow the appropriate implementation of intervention programmes. This implementation allows the appropriate rectification of deficits in children to prevent the exacerbation of scholastic and motor development difficulties in the future (Coetzee & Du Plessis, 2013:46-47).

Recommendations with regard to the lack of test battery variety would be to develop multifaceted test batteries that account for physically disabled children, test all components of motor development, take into account different gender and socio-economic disparities, and are sensitive to cultural diversity in the future.

Other recommendations include increased frequencies of training of appropriate personnel in the education and health systems of South Africa to allow the correct implementation of intervention programmes that can benefit the youth of South Africa.
Recommendations from this study would be to test as many participants as possible for statistical power of effect and significance, to have large sample sizes in order to enhance representation, and to keep as many variables constant as possible such as; the teachers being constant throughout the intervention period as well as keeping the research assistants and test administrators constant, having consistent scoring criteria for scholastic achievement, such as with the use of the Mastery of Basic Learning Areas questionnaire to prevent subjective ratings by the classroom teacher.

The final recommendation for future research would be to use a randomised, control methodological study design in order to enhance internal and external validity and therefore increase the generalisability of the study.
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APPENDIX 1: INFORMED CONSENT

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• Port Elizabeth • 6031 • South Africa • www.mandela.ac.za

INFORMED CONSENT FORM

Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth

Statement by the researcher/person taking consent:

I have accurately outlined the purpose, objectives and procedures of the study in the information sheet and given enough information including the potential benefits and risks to the parent/legal guardian of the potential participant. All information collected in the study will be kept confidential and stored in a safe place with no publication of each participant’s personal information.

I confirm that the participant Mr/Ms: ____________________________________________

School nr.: ______________________

Telephone nr.: ______________________

was given an opportunity to ask questions and that all questions have been answered correctly. I confirm that the learner has not been forced into giving consent, and the consent has been given freely and voluntarily.

Name of researcher: ___Cassandra Lister___

Place: __Nelson Mandela University__ Date: ___May 2017___ Signature: ______

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Statement by the parent/legal guardian

I have read the letter of information of the study or it has been read and explained to me in a language that I understand. I had the opportunity to ask questions about it and any questions I have asked have been answered to my satisfaction. I know the purpose, objectives and procedures, risk and benefits of the study. I understand that I can withdraw my child from the study at any time without further consequences. I received a copy of this written informed consent form and an additional letter of information that I keep myself.

Name of learner: ________________________________________________

Name of parent/legal guardian: ________________________________________

Place: ______________ Date: ______________ Signature: ___________________

If the participant is illiterate

I have witnessed the accurate reading of the consent form to the potential participant and had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness: ___________________________________________________

Place: ______________ Date: ______________ Signature: ___________________

Thumb print of participant:
If you have any further questions, feel free to contact the researcher:

*Cassandra Lister*

*Nelson Mandela University: Master’s Student*  
*Human Movement Sciences Department*  
*Building 123*  
*Tel: 082 964 3179*  
*Email: Listercassie@gmail.com*
APPENDIX 2: INFORMATION SHEET

• PO Box 77000 • Nelson Mandela University
• Port Elizabeth • 6031 • South Africa • www.mandela.ac.za

INFORMATION SHEET

Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth

Identity of researchers and sponsoring institution: This study will be carried out by Cassandra Lister under the supervision of Dr ML Baard from the Human Movement Science Department (Faculty of Health Sciences) at the Nelson Mandela University.

Study objectives: We would like to include your child/children in this study that assesses the effects of the NeuroNet learning movement programme on motor-proficiency, visual-motor integration and scholastic achievement, as well as how these three variables are related. This information will aid in the development of further movement programmes and describe the relationship between motor development, scholastic achievement and physical activity as well as add to the repertoire of research done in South Africa.

Research procedures: Two quintile five schools in the Port Elizabeth area will be included in this study. One school already implementing the NeuroNet learning programme will be included as the experimental group, and a second school not implementing NeuroNet or any other related integrated movement programme will be included as a control group. The experimental- and control groups will receive the same testing procedures to assess motor-proficiency and visual-motor integration.
The study will consist of two testing phases, the pre-testing will occur at the beginning of every term, and post-testing will be completed at the end of every term.

In each testing scenario, each participant will be asked to perform the motor proficiency tests and three tests to assess visual-motor integration. The assessments include the visual-motor integration test, visual-perception test and motor coordination test. The tests of visual-motor skills require the participant to perform copying of geometric shapes, identifying geometric shapes and tracing of geometric forms. The visual-motor integration test will be administered by the researcher with the help of two research assistants within the classroom environment. Each class of learners will require 10 to 15 minutes to perform the test. The visual-perception test will require three minutes per learner to complete and will be administered by the researcher and trained research assistants. The motor coordination will be administered to the learners in a group format and will take five minutes for a group of learners to complete. The motor proficiency tests will assess the fine and gross-motor skills of each child for example; balancing on one leg, catching a ball and drawing geometric shapes. The test is administered by the researcher, with the aid of trained research assistants, and will take approximately 15 to 20 minutes per learner to complete.

To determine the relationship between motor proficiency, visual-motor integration and scholastic achievement, a copy of each participants’ scholastic performance report card from each academic term will be required. This information will be used to determine whether the NeuroNet learning programme influences numeracy, reading and writing scores of grade one learners.

**Risk and benefits:** There are no specific risks associated with this study. The proposed research will provide information on methods that may improve motor proficiency, visual-motor integration and scholastic achievement through specifically designed movement programmes. It will also provide information regarding the efficacy of the NeuroNet learning programme.

**Confidentiality:** All information collected in this study will be coded with a unique personal identification number and stored in a safe locked place. Only researchers of
the study will have access to the data. The officials of the national committee of ethics and research can ask for access to the collected information for the monitoring of good clinical practice. The key findings of the study will be published. Names and personal identities will not be revealed when publishing the study.

Consent: There is no obligation to participate in this study, but your consent is required for the participation of your child/children. Participation of your child/children in this study is voluntary and they can withdraw at any time even after you have signed the consent form.

Alternative to participation: If you do not wish for your child/children to participate or your child decides not to participate, it will not affect you, your family or child's/children's relation to anybody on the study team or at school.

Consequences if you decide to withdraw your child/children from the study and the methodical procedure at the end of the participation: You can decide to withdraw your child/children from the study at any time of the study. However, we would like to inform you that the data gathered before withdrawal could be used for reports and publication purposes.

Any other questions?
Do not hesitate to contact us should you have any further questions or concerns.

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APPENDIX 3: ORAL ASSENT FORM

Assent Form for Child participant

Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth

Explanation of the Study (What will happen to me in this study?)

The study aims to see if the NeuroNet learning programme can make your school work improve. The one test will be drawing shapes, identifying shapes and tracing pictures. The other test is to see what your strength, balance and coordination is like by having to do some physical activities like push-ups. The reading, writing and maths marks from your term three and four reports will be used for the study. The results and reports will be kept private so only myself and my study leader may have access to it. Your name will be coded so that your results will be a secret and no one else will know what your scores have been.

Risks or discomforts of participating in the study (Can anything bad happen to me?)

You may feel tired or out of breath from some of the physical activities but none of these tests will be harmful to you. You must please tell your teacher and parents if you are feeling sick on any of the testing days and if you are hurt in any way.

Benefits of participating in the study (Can anything good happen to me?)
It will be fun to exercise with your friends at school and to see if you can perform all the activities given to you. It will also be an opportunity to practice your drawing and tracing skills.

**Confidentiality (Will anyone know I am in the study?)**

No-one will know that you were part of the study and your name will not be listed in any of the results.

**Compensation for participation/Medical treatment (What happens if I get hurt?)**

Your parents/guardian have been given information about the study and that you should not be hurt in any way. But if you do get hurt, your parents will tell us and we will be able to take you to the doctor for treatment.

**Contact information (Who can I talk to about the study?)**

Your parents can contact Cassandra Lister, 082 964 3179, or ask your teacher if you have any questions about the study.

**Voluntary participation (What if I do not want to do this?)**

You can choose to stop being in the study at any time without getting into trouble.

Do you understand this study and are you willing to participate?

| YES | NO |

I am doing the study because I want to, and I have been told that I can stop at any time I want to and I won’t get into trouble – nothing bad will happen to me if I want to stop.
Yours sincerely,

*Cassandra Lister*

Nelson Mandela University: Master’s Student  
Human Movement Sciences Department  
Building 123  
Tel: 082 964 3179

Email: Listercassie@gmail.com
REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS IN ORDER TO OBTAIN PARTICPANTS FOR A MASTER OF ARTS IN HUMAN MOVEMENT SCIENCE (BIOKINETICS) RESEARCH STUDY

To whom it may concern

My name is Cassandra Lister, I am currently completing my Master of Arts degree in Human Movement Science (Biokinetcis) at The Nelson Mandela University in Port Elizabeth. The research topic is: Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth. The project will be conducted under the supervision of Dr Maryna Baard (Nelson Mandela University, South Africa).

I am hereby requesting consent to approach a number of schools within the Port Elizabeth region to obtain participants for this study.

I have provided a brief outline of my proposed study, along with consent and assent forms to be used in the process. I am currently in the process of obtaining approval from the Nelson Mandela University Research Ethics Committee (Human) and will inform you once the approval has been granted.
Upon completion of the study, I undertake to provide the Department of Basic Education with a bound copy of the full research report. If any further information is required, do not hesitate to contact me.

Thank you for your time and consideration in this matter.

Yours sincerely,

Cassandra Lister

Nelson Mandela University: Master’s Student
Human Movement Sciences Department
Building 123
Tel: 082 964 3179
Email: Listercassie@gmail.com
APPENDIX 5: APPROVAL OF DEPARTMENT OF BASIC EDUCATION FOR PERMISSION TO PERFORM RESEARCH IN SCHOOLS

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS IN ORDER TO OBTAIN PARTICIPANTS FOR A MASTER OF ARTS IN HUMAN MOVEMENT SCIENCE (BIOKINETICS) RESEARCH STUDY

To whom it may concern

My name is Cassandra List, I am currently completing my Master of Arts degree in Human Movement Science (Biokinetics) at The Nelson Mandela Metropolitan University in Port Elizabeth. The research topic is: Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth. The project will be conducted under the supervision of Dr Maryna Baard (NMMU, South Africa).

I am hereby requesting consent to approach a number of schools within the Port Elizabeth region to obtain participants for this study.

I have provided a brief outline of my proposed study, along with consent and assent forms to be used in the process. The proposal was sent to the NMMU Research Ethics Committee: Human (REC-H) for proceeding of the current study. The ethics clearance reference number is: H16-HEA-HMS-001.
Upon completion of the study, I undertake to provide the Department of Education with a bound copy of the full research report. If any further information is required, do not hesitate to contact me.

Thank you for your time and consideration in this matter.

Yours sincerely,

*Cassandra Lister*

NMMU: Master’s Student
Human Movement Sciences Department
Building 123
Tel: 082 964 3179
Email: Listercassie@gmail.com

Standing in for Dr. Ntsiko: M. L. M. L. 
Acting District Director

N. L. 16/04/2017
DISTRICT MANAGEMENT, COORDINATION AND DEVELOPMENT: CLUSTER B

Steve Vukile Tshwete Complex, Zone 6 Zwelethu, 5608, Private Bag X0032, Bhisho, 5605�Republic of South Africa
Enquiries: Noncedo Goduka: Tel: 040 608 4778 Fax: 040 608 4111 email: noncedo.goduka@edu.ecprov.gov.za

N. LUKWE
DEPARTMENT OF EDUCATION
PORT ELIZABETH

APPOINTMENT AS ACTING DISTRICT DIRECTOR – PORT ELIZABETH

1. You are appointed as an Acting District Director with effect from 05 April 2017 – 10 April 2017

2. As an Acting District Director you are expected to perform all the duties in line with SMS handbook and other relevant statues.

3. Please process administratively all the document submitted to the office of the District Director, sign them thereafter and submit those that are supposed to be submitted to the relevant units.

4. Read correspondence on the table of the District Director, from our clientele and comply immediately as required.

5. Generate due submissions and forward them to the relevant units to avoid any delay on matters that will impede effective and efficient service delivery to our clients.

6. I wish you all the best in the execution of your duties.

Yours Faithfully

K.E. NGASO: CHIEF DIRECTOR - CLUSTER B

DATE 05/04/2017
APPENDIX 6: INVITATION TO PRINCIPAL

• PO Box 77000 • Nelson Mandela University

• Port Elizabeth • 6031 • South Africa • www.mandela.ac.za

To whom it may concern

My name is Cassandra Lister, and I am a Master of Arts student in Human Movement Science (Biokinetics) at the Nelson Mandela University. I am conducting research in the field of Human Movement Science on the NeuroNet learning programme implemented in Port Elizabeth schools under the supervision of Dr ML Baard. The Provincial Department of Basic Education has given approval to approach schools for my research. A copy of their approval is contained with this letter. I invite you to consider taking part in this study. This study will meet the requirements of the Nelson Mandela University Faculty of Health Sciences Postgraduate Student Committee as well as The Research Ethics Committee (Human) of the Nelson Mandela University.

Aim of the Research

The research aims to:

- Investigate the effects of an integrated movement programme (NeuroNet Learning Programme) on the motor proficiency, visual-motor integration and scholastic achievement of grade one learners between the ages of six- to nine-years-old in quintile five primary schools in Port Elizabeth.
- To assess the efficacy of the NeuroNet Learning Programme.
- To determine what type of relationship, if any, exists between motor proficiency, visual-motor integration and scholastic achievement.

Significance of the Research Project

The significance of the research is as follows:
It investigates the effect of an integrated movement programme (NeuroNet Learning Programme) on the motor proficiency, visual-motor integration and scholastic achievement of grade one learners between the ages of six- to nine-years-old in quintile five primary schools in Port Elizabeth.

To add to the pedagogical body of knowledge globally and in South Africa specifically, on the efficacy of an integrated movement intervention that targets motor skill, visual-perception and scholastic achievement in a classroom setting in young children in Port Elizabeth.

The combined movement and cognitive approach should inform the practices of physical education teachers at primary schools in the creation of such programmes. Integrated movement programmes specifically caters for children during their fundamental development years as well as challenges teachers to seek ways to screen for, identify and modify such programmes in order to optimise developmental and motor disorders in children. Early identification of children with motor deficiencies is of importance to allow for remedial intervention and to ensure the creation and implementation of optimal learning programmes.

**Benefits of the Research to Schools**

The findings of the study will be disseminated to schools, Eastern Cape Department of Basic Education, and the broader public.

The results could inform curriculum development in physical education and movement programmes during the foundation phase of early childhood development.

**Research Plan and Method**

The data will be collected in two stages for the third and fourth term of 2017 and the first and second term of 2018 (pre-and post-test data) by the sole researcher and three assistants. A pre- and post-test will take place between 24 July and 29 September 2017, and 9 October and 6 December 2017 and then between the 22 January and 23 March 2018, and lastly between the 10\textsuperscript{th} April and 22 June 2018. The data collection
will include two test batteries, the Beery-Buktenica Developmental Test of Visual-Motor Integration in order measure the visual-motor integration of the participants and the Bruininks-Oseretsky Tests of Motor Proficiency Brief Form in order to measure motor proficiency. The participants reports from each term will be needed to obtain the measures of scholastic achievement. Permission will be sought from the learners and their parents prior to their participation in the research. Only those who consent and whose parents/ guardians consent will participate. The data collection will take approximately half an hour for each child with groups of four being used at a time to be more efficient. All information collected will be strictly confidential and neither the school nor individual learners will be identifiable in any reports that are written. Participants may withdraw from the study at any time without penalty. The role of the school is voluntary and the school principal may decide to withdraw the school’s participation at any time without penalty. If a learner requires support as a result of their participation in the study, steps can be taken to accommodate this.

School Involvement

Once I have received your consent to approach learners to participate in the study, I will

- arrange for informed consent to be obtained from participants’ parents
- arrange a time with your school for data collection to take place
- obtain assent from participants

Further information

Any further information that is required can be acquired from the researcher.

Attached for your information are copies of the Parent Information and Consent Form and the Participant Information Statement and Consent Form.
Invitation to Participate

If you would like your school to participate in this research, please complete and return the attached form.

Thank you for taking the time to read this information.

_Cassandra Lister_
Nelson Mandela University: Master’s Student
Human Movement Sciences Department
Building 123
Tel: 082 964 3179
Email: Listercassie@gmail.com

_Dr ML Baard_
Research supervisor
Department of Human Movement Science
Summerstrand Campus (South)
Nelson Mandela University
Port Elizabeth 6031, South Africa
Tel.: +27 41 504-2499/7
Effects of an integrated movement programme on motor proficiency, visual-motor integration and scholastic achievement in grade one learners of quintile five primary schools in Port Elizabeth

School Principal Consent Form

I give consent for you to approach learners in grade one to participate in the effect of an integrated movement programme on motor proficiency, visual-motor integration and scholastic performance in first grade Port Elizabeth learners.

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- I may decide to withdraw the school’s participation at any time without penalty
- Grade one learners was invited to participate and that permission was sought from them and also from their parents.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained was treated in strictest confidence.
- The learners’ names will not be used and individual learners will not be identifiable in any written reports about the study.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings was made available to the school.
- I may seek further information on the project from Cassie Lister 0829643179

__________________________  ____________________________
Principal                  Signature

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APPENDIX 8: NEURONET BROCHURE

NeuroNet’s 4 Key Concepts

1. Learn Independently
   - Watch and learn, then think and do.
   - Engage in productive trial and error problem solving.

2. Make the speed and accuracy network
   - Develop fluency in early reading, handwriting, and math skills.
   - Learn how to use what you know to enhance new learning.

3. Get your brain to practice what you want your brain to learn
   - To develop fluency, you must practice fluency.

4. Self-evaluation is the key to motivation
   - Learn to self-evaluate and to equate effort and practice with improvements in performance.

About the Founder

NeurOnet began as a program to help struggling learners become independent learners. The program was developed by Nancy Stow, an audiologist whose work centered around helping children improve their coordination of motor and cognitive skills in an educational environment that encourages self-evaluation and trial and error problem solving.

Nancy has been a featured speaker at educational and brain-based learning conferences in cities throughout the US, Europe, Central, and South America. Her popular books include Auditory Processing: From the Ear to the Brain and Automaticity: Making the Speed and Accuracy Learning Network have been downloaded more than 100,000 times.

Nancy has a degree in speech education from KSU and a graduate degree in speech and hearing science from Washington University in St. Louis.
Developing Academic Skills

Neurofit is a research-based learning readiness program designed to help students develop strong foundational reading, math, and handwriting skills. Neurofit facilitates Learning through Movement, an approach based on neuroscience research on the way neural networks are created and strengthened by combining rhythmic exercise with drills in academic skills. As a result, we can achieve greater automaticity or fluency in those skills. The following are specific ways Neurofit strengthens foundational reading, writing, and math skills outlined in Common Core Standards.

Oral Language and Listening

Students learn to use rhythmic speech in movement multi-tasking exercises. This helps them develop fluency in speech and movement. As students engage in the rhythmic movement exercises, they must listen and respond, on-time, to rhythm and number prompts. The use of rhythmic speech in Neurofit exercises helps students hear the sequences of phonemes in words and requires them to elongate and over-enunciate consonant and vowel sounds.

Word Recognition and Extending Vocabulary

Students do fast-picture naming and rhyming as they exercise. On-time naming is an important visual-verbal processing skill that indicates mastery of word parts and meanings.

Math, Spatial and Numerical Reasoning

Students practice counting, using spatial reasoning to calculate number sizes, and performing addition and subtraction. Exercises are rhythmic and require students to perform calculations on time. Fast retrieval of math facts facilitates learning higher level math (multiplication, division, algebra, geometry) in later grades.

Handwriting

Lined, Talk and Write exercises develop speed and accuracy of written forms, from geometric lines and shapes to numbers and letters. Drilling with air writing, students use gross motor skills to write large shapes and letter forms in the air. Then they repeat the handwriting practice in their books to reinforce the names and navigation patterns of numbers and letters.

Eye-Movement Coordination

Students learn to do exercises that develop coordinated eye movements. Eye-tracking skills are essential for seeing visual details, for tracking left to right through rows of print while reading, and for tracking up and down through lines of print while solving math problems.

Motivation to Learn

Neurofit helps students develop learning readiness through exercises that leverage our understanding of biology and neuroscience. Neurofit develops the brain organization children need to become successful at reading, handwriting, and math.

To request a quote or for more information call 352-450-5625
Research

Early childhood is often referred to as the “skill hungry years” during which strongest emphasis should be put on physical activities promoting motor and cognitive development.
Mental Health and Physical Activity, 2013.

Children who participate in cognitively enriched motor activities are better at simultaneously managing tasks.
Mental Health and Physical Activity, 2013.

If a young child has difficulty with rhythmic timing, this may hinder the development of their phonological awareness and reading ability.

Handwriting facilitates reading acquisition in young children.

Researchers have discovered that not only does brain activity alter as a consequence of motor skill learning, but structural brain changes also occur.
Cerebral Cortex, 2013.

Architecture of cerebral fiber pathways supports spatio-temporal coherence, developmental path-finding, and incremental rewiring.
Wedeen, 2012.

Program Offerings

Classroom Enrichment Program

NeuroNet can be implemented in general education classes, as an academic intervention for struggling learners, or in an after-school program.

MATERIALS INCLUDED IN PROGRAM
1. Movement Exercises
2. Vision Exercises
3. Picture Pages
4. Listen, Talk and Write books

TEACHER TRAINING
Classroom Enrichment training includes the neuroscience behind NeuroNet, program setup, and best practices for implementation. Training is required and is available as a live in-service or an online course.

SUPPLEMENTAL MATERIALS
Each student requires one step stool, one bean bag, and two 2-pound weights. The weights can be replaced by hand claps instead of weight bumps, or by using water bottles. The cost for these materials is approximately $70 per student. Vendor recommendations for purchasing supplemental materials will be provided.

NeuroNet Accreditation

A school receives provisional accreditation in the first year of implementing NeuroNet provided the school meets the following criteria:
1. NeuroNet is implemented in one or more grade levels school wide.
2. All teachers implementing NeuroNet have successfully completed training.
3. Program implementation occurs at least 4 days a week for all teachers as measured by program usage data.

Provisional status is removed once the school meets the above criteria for one year.
### Program Order Form

#### Classroom Enrichment Teacher Software License
- Each teacher will need a software license and each license includes the following:
  - 4-hour online teacher training
  - Software and Tech support
  - PDF of Listen, Talk and Write pages to print & photocopy as needed

#### Listen, Talk and Write Books
- 8 Listen, Talk and Write Books
- 1 Assessment Book

#### Payment Information
Submit orders by fax, mail, or email along with a purchase order. Payment is due within 30 days of delivery of all program materials. Rates may vary.

**Address**
NeuroNet Learning
161 S E 2nd Place, Ste. 117
Gainesville, FL 32601

**Phone** 352-452-5625
**Fax** 352-288-2400
**Email** info@neuronetlearning.com

#### Teacher Software License
(Number of Classrooms)
<table>
<thead>
<tr>
<th>Pre-K</th>
<th>Kindergarten</th>
<th>First Grade</th>
<th>Second Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Listen, Talk and Write Book Set
(Number of Students)
<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>First Grade</th>
<th>Second Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**School**

**Teacher**

**School Name**

**Address**

**City**

**State**

**Zip**

**Contact Name**

**Phone**

**Email**

**FAX**

**Date**
APPENDIX 9: ETHICS APPROVAL LETTER

[Image of a letter from Nelson Mandela Metropolitan University]

Ref: [H17-HEA-HMS-001 / Approval]
Contact person: Mrs U Spies
12 June 2017

Dr M Baard
Faculty: Health Sciences
South Campus

Dear Dr Baard

EFFECTS OF AN INTEGRATED MOVEMENT PROGRAMME ON MOTOR PROFICIENCY, VISUAL-MOTOR INTEGRATION AND SCHOLASTIC ACHIEVEMENT IN GRADE ONE LEARNERS OF QUINTILE FIVE PRIMARY SCHOOLS IN PORT ELIZABETH

PRP: Dr M Baard
PI: Ms C Lister

Your above-entitled application served at Research Ethics Committee (Human) for approval. The ethics clearance reference number is H17-HEA-HMS-001 and is valid for three years. Please inform the REC-H, via your faculty representative, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project.

Yours sincerely

[Signature]

Prof C Cilliers
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development
    Faculty Officer: Health Sciences