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To evaluate the effectiveness of participation in specific motor learning activities, on the academic learning areas of Grade 2 learners.

Cherese Jones

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Prof. P.E. Krüger

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Prof Kruger, study leader

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Gr 2 Educators of St.Paulus Pre- and Primary School

Family and friends

DEDICATION

Learners of St. Paulus Pre- and Primary School for giving me the insights of the shortcomings of the absents of general motor learning activities.

To all children – not to be deprived from being developed and stimulated through physical activity.

To all schools – to reinforce physical activity as one of the important fundamentals of child development.

SYNOPSIS

TITLE	To evaluate the effectiveness of participation in specific motor learning activities, on the academic learning areas of Grade 2 learners
CANDIDATE	Cherese Jones
PROMOTOR	Prof. P.E. Krűger
DEGREE	Magister Atrium (Sports Science)

Physical activities contribute to children's well being; therefore, it is an instructional priority for all schools and an integral part of all children's educational experience. High-quality physical education instruction contributes to good health, develops fundamental and advanced motor skills, improves children's self-confidence, and provides opportunities for increased levels of physical fitness that are associated with high academic achievement.

This research study aimed to ascertain whether there was any effect on the experimental group's learning progress after participating in a specific motor learning activity program. The researcher did this in the form of an experimental study in which the 1st term evaluation reports has been compared to that of the 3rd term, after the learners have participated in a specific motor learning program. A research group consisting of 42 learners was compared to a control group of the same number and the same age. The experimental group has participated in a 16 week training program, consisting of specific motor learning activities, while the control group has only performed their regular daily activities.

Subsequently the participants' academic evaluation reports has been compared in order to note if there are any differences in academic learning areas. Out of the 16 academic learning areas, nine (9) academic learning areas showed a bigger improvement of the experimental group to that of the control group (56.25%), five (5) learning areas showed a decline (31.25%) and two (2) learning areas was not affected (12.5%) (no improvement or decline in the performance of the learning area).

The results from this study has allowed for an assessment of the effect of specific motor learning activities on academic learning areas, with a highlight on Languages (Afrikaans and English) Read and Write, Numeracy, Behaviour, Concentration, Social Development and Personal Development, and has concluded that organized motor learning activities administered on a regular basis has a successful outcome on academic learning areas. It also generated useful information and a motor learning programme, which can contribute to clearer understanding of the role of movement in helping a child achieve in his/her academics.

Key words: motor skills, experimental study, comparison, academic learning areas

OPSOMMING

TITEL	Evalueer die doeltreffendheid van deelname aan spesifieke motoriese leeraktiwiteite op akademiese leerareas van Graad 2 leerders
KANDIDAAT	Cherese Jones
PROMOTOR	Prof. P.E. Krűger
GRAAD	Magister Atrium (Sportwetenskap)

Fisiese aktiwitieite dra positief by tot kinders se algemene welsyn. Om hierdie rede is dit ‘n absolute en on-onderhandelbare prioriteit vir alle skole, en ‘n integrale deel van alle kinders se opvoedkundige ervaringswêreld. Fisiese opvoeding van ‘n hoë gehalte dra by tot goeie gesondheid, dit ontwikkel fundamentele en gevorderde motoriese vaardigheid, dit verbeter kinders se selfvertroue en dit skep geleenthede vir verhoogde vlakke van fisiese fiksheid. Al hierdie voordele hou verband met ‘n verhoodge akademiese prestasie.

Hierdie navorsingsprojek het ten doel om vas te stel of daar enige uitwerking op die eksperimentele groep se leervordering was wanneer hulle aan ‘n spesifieke motoriese leeraktiwiteitsprogram deelgeneem het. Die navorsing was eksperimenteel van aard, waarin die evaluasieverslae van die eerste termyn vergelyk was met die van die derde termyn, nadat leerders aan ‘n spesifieke motoriese leerprogram deelgeneem het. Die navorsingsgroep het bestaan uit 42 leerders en was vergelyk met 'n kontrole-groep van dieselfde grootte en ouderdom. Die eksperimentele groep het aan ‘n 16 week opleidingsprogram deelgeneem, wat bestaan het uit spesifieke motoriese leeraktiwiteite, terwyl die kontrolegroep slegs aan hul normale daaglikse aktiwiteite deelgeneem het.

Die deelnemers se akademiese evaluasieverslae was vergelyk om vas te stel of daar enige verskille in die akademiese leerareas was as gevolg van die addisionele spesifieke motoriese leeraktiwiteite. Uit die 16 akademiese leerareas het die eksperimentele groep in nege (9) van die leerareas ’n groter verbetering getoon (56.25%) as die kontrole groep, in vyf (5) van die leerareas was daar 'n afname

(31.25%), terwyl daar in twee (2) van die leerareas geen verandering plaasgevind het nie (12.5%). Daar was dus geen verbetering of afname in die prestasie van die leerarea nie.

Die resultate van hierdie navorsingstudie het ‘n waardebepaling moontlik gemaak van die invloed van spesifieke motoriese leeraktiwiteite op die akademiese prestasie, waarin die klem geplaas is op tale (Afrikaans en Engels) se lees en skryf, wiskunde, algemene gedrag, algemene konsentrasie, sosiale ontwikkeling en persoonlike ontwikkeling. Die assessering het vasgestel dat georganiseerde motoriese leeraktiwiteite, wat op ’n gereelde basis geadministreer word, ‘n positiewe uitwerking het op akademiese leeraktiwiteite. Dit het ook bruikbare inligting saam met ’n motoriese leerprogram gegenereer, wat kan bydra tot ’n meer duidelike begrip van die rol van beweging en hoe dit ’n kind kan help om sy/haar akademiese doelwitte te bereik.

Sleutelterme: Motoriese leer vaardighede, eksperimentele studie, vergelyking, akademiese leerareas

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GLOSSARY: ACRONYMS

H_0	Null Hypothesis
H_1	Alternative Hypothesis
T1	Term one
T3	Term three
1^{st}	First
2^{nd}	Second
3^{rd}	Third
KD	Knowledge Development
KU	Knowledge Utilization
D&D	Design and Development
SMA	Supplementary motor area
M1	Primary motor cortex
CNS	Central Nervous system
PNS	Peripheral nervous system
ANS	Autonomic nervous system
ABC	Attention, Balance and Coordination
URTI	Upper respiratory tract infections
T2DM	Type 2 Diabetes mellitus
VMI	Visual-Motor Integration
NUM – PFA	Numeracy – Patterns, Functions and Algebra

GEN – CON General concentration

GEN – BEH General behaviour

LS – SD Life Skills Social Development

LS – PD Life Skills Personal Development

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Physical activities contribute to children's well being; therefore, it is an instructional priority for all schools and an integral part of all children's educational experience. High-quality physical education instruction contributes to good health, develops fundamental and advanced motor skills, improves children's self-confidence, and provides opportunities for increased levels of physical fitness that are associated with high academic achievement.

Development of children is the result of a complex interaction between hereditary, growth, maturation, environmental domains and has a biological and behavioural context. Biological development involves the differentiation of cells that enables them to perform specialized functions or to refine functions that already exist. Behavioural development relates to the evolution of intellectual, psychological, and sociological attributes. Motor development of children could be defined in terms of progressive changes in motor performance, resulting from growth, maturation, and biological and behavioural development. It is known that mental, social, educational, and emotional maturity is positively related, and personality traits are related to academic and physical achievement (Ismail, & Gruber, 1971; Eunicke-Morell, 1989; Vernon, & Mori, 1992; Etnier *et al*., 1997; Dolenec, 2001; Dolenec *et al*., 2002; Dolenec *et al*., 2004).

The associations of motor and cognitive abilities for both boys and girls are positive and significant (Planinšec, 2002). On both sexes, the motor dimensions with the strongest associations with the cognitive abilities are those of coordination and speed of movement. Despite some differences between boys and girls, they still have a lot in common since the most important latent motor dimensions prevailing in the connection between motor and cognitive dimensions are similar. Cognitive abilities are responsible for the processes of foresight, planning, decision making, as well as comparison and processing of information with the use of long-term memory in solving problem situations. Motor tests of coordination also represent problem situations that need to be solved efficiently (Dolenec, 2001).

In addition, this research will contribute to the explanation of specific mental processes (cognitive learning areas) that are improved by exercise and assist in an understanding of the underlying mechanisms of these improvements (Clark & Harrelson, 2002). This research study aims to ascertain whether there is any effect on the experimental group's learning progress when participating in a specific motor learning activity program.

1.2. DEFINING THE RESEARCH PROBLEM

The research problem has been defined as the following:
Whether participation in specific motor activities has an effect on specific areas of cognitive functioning in Grade 2 learners.

1.2.1 Sub problem statement

Determining the differences in academic evaluation results, before and after partaking in specific psychomotor learning activities.

1.3. AIM AND HYPOTHESIS

Aim: To determine whether participation in specific motor learning activities has any effect on academic learning areas.

H_0: Participation in specific motor learning activities for a period of time will not result in an improvement in academic learning areas.

H_1: Participation in specific motor learning activities for a period of time will result in an improvement in academic learning areas.

1.4. RELEVANCE AND MOTIVATION FOR THE STUDY

This study is being done in order to determine whether there is a significant difference in academic evaluation reports before and after participation in specific motor learning activities. These physical activities significantly contribute to the learner's well being; therefore, it is a precedence for all schools and a fundamental part of our learner's educational experience. The positive contribution of high-quality physical education instruction to life is associated with high academic achievement.

Mastering fundamental movement skills at an early age establishes a foundation that facilitates further motor skill acquisition and gives learners increased capacity for a lifetime of successful and enjoyable physical activity experiences. Similarly, the patterns of physical activity acquired during childhood and adolescence are likely to be maintained throughout one's life span, providing physical, mental, and social benefits (Newell, 1991). Insofar as physical activity has been associated with increased academic performance, self-concept, mood, and mental health, the promotion of physical activity and exercise may also improve quality of life. Some research suggests that exercise positively affects the hippocampus. The hippocampus is vital for memory and learning. It is important that we expand on these studies in order to establish exactly how exercise affects the brain and it's functioning. Overall, these groups of studies mentioned in the literature review are suggesting that an active lifestyle plays an important role in maintaining the function of the brain. If exercise improves mood, it follows naturally that it would improve the thinking process. Most people cannot think optimally when they are depressed (Fabel *et al*., 2003.).

In addition, this research will contribute to the explanation of specific mental processes (cognitive learning areas) that are improved by exercise and assist in an understanding of the underlying mechanisms of these improvements (Clark & Harrelson, 2002).

1.5 STUDY DESIGN

The study design is a true experimental study. This randomised-group design leads to the conclusion that the significant differences in academic evaluation reports between the experimental group and the control group are due to participation in the specific motor learning program.

A blind setup will be used, in which the control group will not know what motor learning activities the experimental group is participating in.

1.5.1 Research approach

A combination of qualitative and quantitative research methods will be utilised in this study. When qualitative and quantitative methods of data collection are mixed, the process is term triangulation (De Vos & Fouche, 1998). Cresswell (1994) presents three models to design a study that combines the qualitative and quantitative paradigms in a single project. The three models are the two-phase model, the dominant-less-dominant model and the mixed methodology design model. For the purpose of this study the researcher will use the two-phase model.

Cresswell (1994) describes the two-phase model in which the researcher proposes to conduct a qualitative phase of the study and a separate quantitative phase. The advantage of this approach is that the two paradigms are clearly separate; it also enables a researcher to thoroughly present the paradigm assumptions behind each phase.

The first phase in this study consists of completing the need assessment with the teachers and occupational therapist. During this phase the qualitative approach will be the most effective in gaining the most and richest data. During the second phase of the research, the quantitative approach will be used to measure the impact of the training program on the participants.

1.5.2 Type of research

The type of research that the researcher will conduct will be applied research. Applied research addresses the current problem that the professional person experiences in practice (Arkava & Lane, 1983). De Vos and Fouche (1998:20) define applied research as research "…*geared to the development of knowledge and technology with a view to achieving meaningful intervention*."

For this study intervention research in the context of applied research is the most appropriate type of research. According to Schilling (in De Vos, 1998), social work interventions include strategies that draw on and seek to strengthen the social ties between the individual and the social environment. Intervention is an action undertaken by a social worker to enhance or maintain the functioning and wellbeing of an individual, family, group, community or population. De Vos & Fouche (1998) outline three specific types of intervention research. All three types of intervention research aim to further knowledge in an already identified field of research and at improving intervention as a result. According to De Vos & Fouche (1998:69) "…*as applied research, all three are directed towards shedding light on or providing possible solution to practical problems".* These are:

- Empirical research, to extend knowledge of human behaviour relating to human service intervention -referred to as intervention knowledge development, or KD
- The means by which the findings from intervention KD research may be linked to, and utilized in, practical application -referred to as intervention knowledge utilization, or KU; and
- Research directed towards developing innovative interventions -referred to as intervention design and development, or D&D.

For the purpose of this study, the D&D model of intervention research will be followed in order to develop a training program by the sports educator / researcher for the grade 2 learner, implement the program (intervention), and evaluate the effectiveness of the program.

The intervention research model of Rothman and Thomas (D&D model) (1994) is a phase model consisting of six phases. For the purpose of this study, the researcher will focus only on the first five phases of the intervention process. The first five phases include: problem analysis and project planning; information gathering and synthesis; design; early development and evaluation; and advanced development. Dissemination, the sixth phase, is not the intention of this study. The research procedures will be discussed during the process of intervention research.

1.5.3 Problem analysis and project planning

According to Thomas (1984) in De Vos & Fouche (1998) there are two factors involved in identifying a condition as a problem:

- Recognition that professional and/or community standards (or norms) exist ~ based on social values that define given levels of behaviour or well-being as appropriate; and
- Discrepancies between the standards or norms and the existing behaviour or states of wellbeing of given individuals or groups.

Through problem analysis a problematic human condition can be identified which precedes the development of technology to address it. Such analysis consists of determining one or more of the following intervention shortcomings in how the problematic conditions can be confronted (De Vos & Fouche, 1998):

- the extent of the difficulty, such as its incidence or prevalence;
- the component aspects of the problem;
- the possible causal factors; and
- the effects of the problem, including the behavioural, social and economic accompaniments

The next phase is to determine the procedures of the intervention. It is necessary to determine whether relevant interventions already exist and, if so, whether further development is merited. (De Vos & Fouche, 1998.)

1.5.4 Identifying and involving clients

The intervention researcher chooses a population with whom to collaborate. A population is selected whose issues are of current interest. The problem that has been analyzed in this study is whether motor activities have an effect on specific areas of cognitive functioning. The existence of such a problematic human condition is often not recognized by the public or professionals. The objective of the analysis phase is to bring about such recognition. Researchers that address the problem of important constituencies will receive more support from the target population, professional community and general public (Rothman & Thomas, 1994). The researcher identified the target population as grade 2 learners (male and female) of St. Paulus Pre–Primary and Primary School in Pretoria, South Africa.

1.5.5 Setting

Specific motor learning activities has been presented to the learners of St. Paulus Pre-Primary and Primary School. It has taken place during physical education class lessons, presented by the researcher. The 1st term academic evaluation report has been compared to that of the 3rd term to note any improvement in some cognitive functioning. The academic evaluation reports of the participants has also been compared to a control group which has not participated in the specific physical education program. Recording and data analysis has also been conducted by the researcher.

1.5.6 Research / Patient object selection

Inclusion criteria:

Physically and mentally able Grade 2 learners (male and female) of St. Paulus Pre – Primary and Primary School.

Exclusion criteria:

The research study has excluded the testing of physically disabled learners, mentally impaired learners, and learners with medical conditions.

1.5.7 Measurements

A randomly selected group of eighty four (84) learners has taken part in the study. The experimental group (n-42) has performed a variation of specific motor learning activities (Appendix A). The number of activities has been presented and supervised by the researcher, starting in the 2nd term of the academic year and continuing until the end of the 3rd term in the same academic year. Thereafter, a determination of improved academic learning results (overall achievement) has taken place by comparing the 1st term academic evaluation report to that of the 3rd term.

The academic evaluation reports of the experimental group has also be compared to the control group (n=42) which has not participated in the specific motor learning program, in order to eliminate possible bias caused due to the academic learning effect and adaptation throughout the cause of the year.

All measurements will lead to the findings if there is any effect on the experimental group's academic results after administration of the specific motor learning program.

1.5.8 Data analysis

A comparison between the research group's and control group's academic evaluation reports has been conducted before and after administration of the specific motor learning program. The correlations coefficient has been recorded to reflect the effectiveness of the motor learning program.

1.5.9 Sample size

Forty two randomly selected grade 2 learners, both male and female, has represented the experimental group, and the same number of learners of the same age, also randomly selected, has represent the control group. Each of the pupils in grade 2 has been assigned a number-name alphabetically. Every second even number will be assigned to the experimental group and every second uneven number will be assigned to the control group.

1.6. EHTICAL CONSIDERATIONS

An informed consent form (Appendix B) has been given to the participants (the experimental group, as well as the control group) and their parents, which has included the researcher's responsibilities.

The following basic elements of informed consent has been followed:

- A fair explanation of the procedures to be followed, including an identification of those that are experimental;
- A description of the possible discomforts and risks;
- A description of the benefits to be expected;
- A disclosure of appropriate alternative procedures that would be advantageous for the participant;
- An offer to answer any enquiries concerning the procedures; and

- An indication that the participant is free to withdraw consent and to discontinue participation on the project or activity at any time.

There has been qualified first aid personnel as well as a first aid kit on hand whilst performing the required tasks.

- The rights of the participant will be considered by the researcher;
- The right to privacy or non-participation;
- The right to remain anonymous;
- The right to confidentiality; and
- The right to expect experimenter responsibility.

The following basic ethical procedures has also been followed:

- Life, health and privacy of subjects will be protected;
- Generally accepted scientific principles will be adhered to;
- Submission of the research proposal to Humanities Ethics Committee for ethical clearance; and
- If risks outweigh benefits, the research will be ceased.

CHAPTER 2

LITERATURE REVIEW

2.1 PSYCHOMOTOR LEARNING

Psychomotor learning, also known as physical activity, is the development of muscles to work in organized patterns guided by signals from the environment. It is the relationship between cognitive functions and physical movement in education. Psychomotor learning is demonstrated by physical skills such as movement, coordination, manipulation, dexterity, grace, strength and speed; actions which demonstrate the fine motor skills such as the use of precision instruments or tools, or actions which display gross motor skills such as the use of the body in dance, musical or athletic performance. In psychomotor learning research, attention is given to the learning of coordinated activity involving the arms, hands, fingers and feet, while verbal processes are not emphasized (Wikipedia, 2010). When an individual learns physical movements, it causes changes in the individual's motor cortex. The more practiced a movement is, the stronger the neural encoding becomes (Bloom, 1956).

Nearly half of the young people (early school age to pre-adolescence, 6-13 years) do not participate in vigorous physical activity on a regular basis. Fewer than one in four children report getting at least half an hour of any type of daily physical activity and do not attend any school Physical Education classes. In America (June 2001), ABC News reported that school children spend 4.8 hours per day on the computer, watching TV, or playing video games. The combination of: the impact of computers, video games, school funding cuts and public apathy, have left Illinois as the only state that still ensures daily physical education. This is a far cry from the 1960s, when President John F. Kennedy made physical fitness a priority for Americans of all ages. These sedentary tendencies represent a real health crisis (President's Council on Physical Fitness and Sports, 2002).

Studies conducted in French and Canadian elementary schools over a period of four years found that regular physical activity had positive effects on academic performance. Spending one third of the school day in physical education, art and music improved not only physical fitness, but attitudes toward learning and subsequent test scores. These findings reflect those from an analysis of 200 studies on the effects of exercise on cognitive functioning, which also suggests that physical activity promotes improved learning (Martin & Chalmers, 2007).

In a 2007 report from the American Academy of Pediatrics, it was stated that play promotes not only behavioural development, but also brain growth (Frost *et al.,* 2005). The University of North Carolina's *Abecedarian Early Child Intervention program* found that children who received an enriched, play-oriented parenting and early childhood program had significantly higher IQ's at age five than that of a comparable group of children who were not in the program (Barnett, 1995).

2.2 MOTOR LEARNING

Motor learning is a change, resulting from practice or a novel experience, in the capability of responding. It often involves improving the smoothness and accuracy of movements and is obviously necessary for complicated movements such as speaking, playing the piano and climbing trees. However, it is also important for calibrating simple movements like reflexes, as parameters of the body and environment change over time (Wikipedia, 2014).

All essential movements made by a newborn are actually reflexes. Motor development occurs as the child gains control over the movement of his/ her body. No one is born coordinated; the reason being that coordination develops through three basic levels. According to O'Dell and Cook (1997), the reflex level provides the foundation for all motor development. Reflex development occurs first, followed by gross motor and then fine motor development. O'Dell and Cook (1997) conducted extensive research on the Symmetric Tonic Neck Reflex and their findings reinforced their convictions that academic success is based significantly on early motor development.

Motor learning is "relatively permanent", as the capability to respond appropriately is acquired and retained. The main components underlying the behavioural approach to motor learning are structure of practice and feedback given. The former pertains to the manipulation of timing and organization of practice (potentially for different sub-tasks or variations of the task) for optimal information retention, while the latter pertains to the influence of feedback on the preparation, anticipation, and guidance of movement (Wikipedia, 2014).

2.3 THE MOTOR LEARNING PROCESS

Motor learning is a process of acquiring, completing and using motor information, knowledge, experience, and motor programmes (Adams, 1977). It is closely connected to mental abilities, motor abilities, foreknowledge, and the cognitive and conative characteristics of an individual as well as his familiarity with the theoretical bases of movement technique. Based on Hay's (1985) biomechanical studies, it may be ascertained that running, as the most elementary manifestation of human motor abilities, involves more than 80 muscle groups and 46 bones of the loco motor system. To facilitate the correct performance of a motor action, optimal coordination of movements is necessary. Abernethy *et al*. (1997) distinguishes between three phases in the process of motor learning: the verbal-cognitive phase, during which a new movement structure is first identified and then understood; the associative phase, during which several elements of the movement structure are integrated and adapted to the changing circumstances; and the autonomous phase, during which movement becomes automatic and results in fewer errors. During the first phase, a beginner executes a series of unnecessary movements, activates muscles that are not relevant and is unable to bring them into balance. Consequently, his starting position and movement rhythm are incorrect, while his posture is stiff. This phase of motor learning lasts from 15 to 30 hours. In the second, associative phase, the quality of movement improves substantially. Movements are already smoother and more relaxed, while superfluous movements gradually vanish. In the motor part of the central nervous system a notion appears as a motor stereotype. This phase lasts from 3 to 5 months. The third, autonomous phase, is that of movement automation, where the individual kinematic and dynamic parameters of movement are optimally integrated. This lasts for several years and is never quite finished. The motor stereotype collapses only in extremely unpredictable circumstances such as fatigue, enormous pressure or stress (Abernethy *et al*., 1997).

Fitts and Peterson (1964) and Fitts and Posner (1967) suggest that motor skill acquisition follows three stages (Table 2.1).

Table 2.1: Three stages of motor learning

Stage	Process	Characteristics	Other name
Cognitive	Gathering information	Large gains, inconsistent performance	Verbal-motor stage
Associative	Putting actions together	Small gains, disjointed performance, conscious effort	Motor stage
Autonomous	Much time and practice	Performance seems unconscious, automatic and smooth	Automatic stage

Magill *et al*.'s (1992) definition of motor learning divides muscle activity into seven phases:

- The selection and innervation of those muscles necessary for the efficient execution of a movement;
- Sequencing (the correct sequence of muscle activation);
- Time structuring of the movement (the duration of the activity of an individual muscle during the entire movement);
- Gradation (varied application of the power of the engaged muscles);
- Timing (adapting the structure of the movement to external conditions);
- Alternative movements (selection of the optimal movement structure in view of the current situation); and
- Movement control (movement automation and movement adaptation in non-standard circumstances).

Performing a certain movement is only possible if a suitable motor programme exists for it. Schmidt (1977) defines a motor programme as a multitude of commands that travel from the central nervous system to the muscles, and which are defined prior to the movement. The author distinguishes between short-term and long-term motor memory. Short-term motor memory registers visual, auditory, kinaesthetic and other stimuli from the environment. It is useful for the current process of movement control and is a working memory that only lasts for 30 seconds. The long-term motor memory stores well-mastered and automated motor tasks. Both memories are important in motor learning – the first one particularly during the initial stage of learning. No motor learning is ideal or equally efficient at any time. Most motor structures need to be complemented and adjusted to new circumstances by motor control. Motor control distinguishes between an open circle system and a closed circle system (Schmidt, 1991). Movements lasting up to 200 milliseconds (reflex, ballistic movements) are centrally monitored (the open circle system) and require that the motor programme be defined beforehand – including all the details. Movement or its individual components are independent of the feedback information as movement control is exerted subconsciously by higher centres of the central nervous system. Once this programme starts, corrections are no longer possible. Movements lasting longer than 200 milliseconds (the closed circle system) allow for the correction of error. Preparation of a programme, the programme itself and control over how it is implemented are important in the execution of movement. Each movement is realised in a closed system of spatial and temporal coordinates. Of particular importance are the kinaesthetic receptors, synchronising movement by regulating muscle and tendon tonus (Golgi tendon receptors), Ruffini free nerve endings and Pacinian corpuscles located in joints and per articular tissue (Enoka, 1998).

Motor learning of a given sports technique requires a plan which Schmidt (1977) defines as a "*scheme*" being stored in the motor memory. The movement scheme has four elements:

- Initial conditions such as information about the environment, the position of body parts, position of the tool (e.g. club, racquet, ball), the grip and balance of the body;
- Information about the speed, amplitude and force of the swing;
- Information about movement transmitted by kinaesthetic receptors; and
- Information about the reaction outcome in view of the set goal.

The motor process starts with a definition of the desired result of movement and establishment of the initial conditions. Implementation of the motor programme starts on the basis of stored information about previous movement experience. A precondition for efficient motor learning is an optimally accurate notion of movement. Notions of movements are formed from the basis of visual and motor perceptions combining with verbal and mental activity; at the same time the pre-existing notions are also activated (Tancig, 1996). The concept of a motor programme is related to information processing in the time period during which a motor task is being performed. There is a great difference between a conscious execution of a motor task (verbal–cognitive phase) and an automated execution. In automated movements, many intermediate stages disappear; the transition from sensory information to execution of the movement is direct and there is no symbolic interpretation such as what was necessary at the very beginning (Magill, 1989).

In the motor learning process two types of feedback are important: sensory feedback and indirect feedback. Sensory feedback enables motor control – particularly in the initial phase of motor learning. This information is transmitted by different receptors:

- exterioceptors (eye, ear);
- tactile receptors (receptors in the skin of the palm and fingers); and
- proprioceptors (receptors in muscles, joints, tendons, epimysia) (Schmidt, 1991).

Indirect feedback is more frequent in the second and third phases of motor learning and depends on knowledge of the result of the movement. Exact knowledge of movement execution, experience, highly differentiated tactile and kinaesthetic sensations and anticipation of external circumstances are the factors that also enable a player to apply the optimal technique in unpredictable conditions. The ability of motor learning may vary considerably in each individual. It depends on the perception of information, comparison and processing of information, age, motivation, motor experience as well as short-term (working) and long-term memory. Motor learning is a process of storing information in long-term memory through the exercise or repetition of motor tasks (Keele & Summers, 1976).

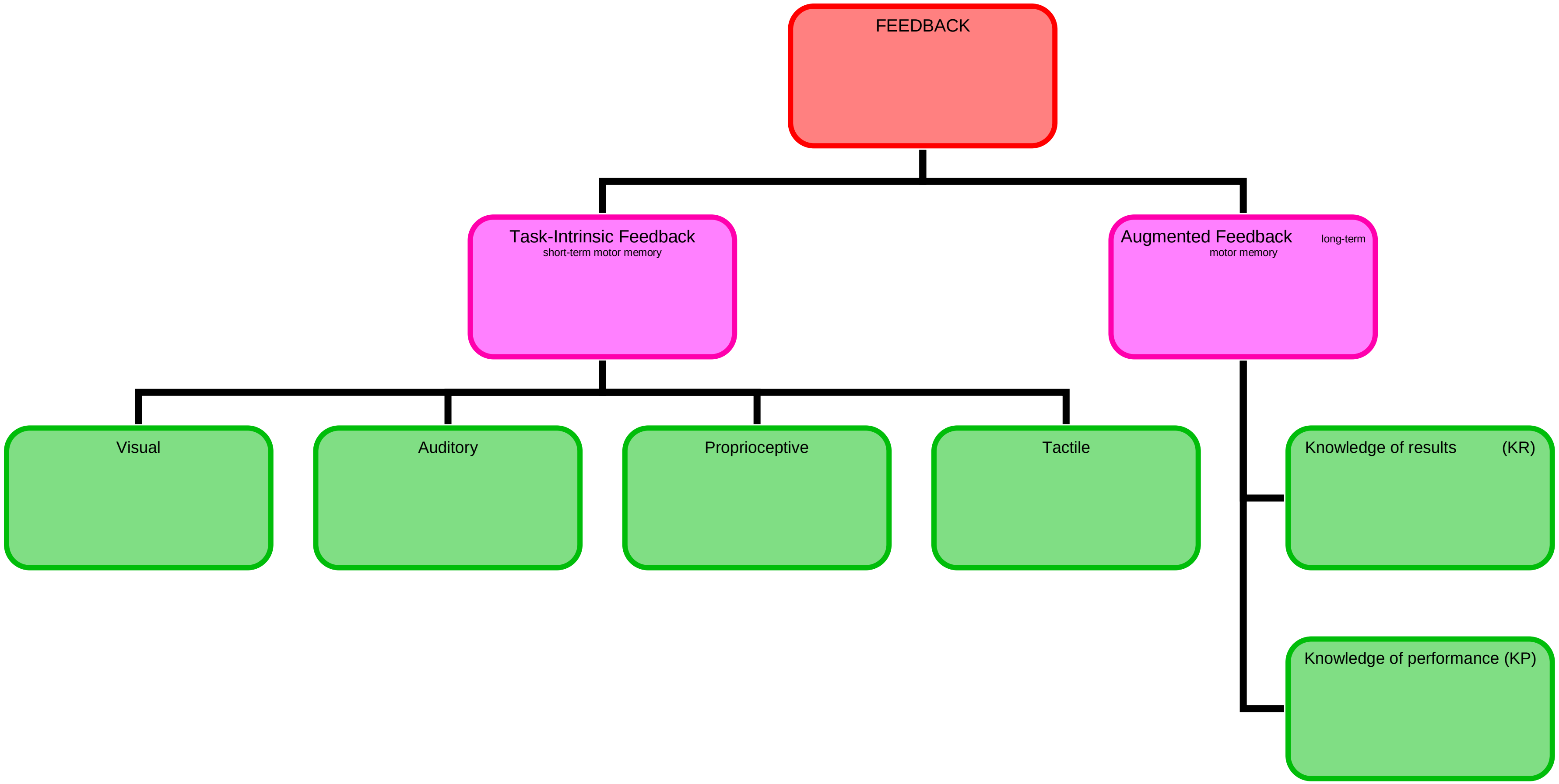

Figure 2.1: Motor control based on the closed circle system (Schmidt, 1991)

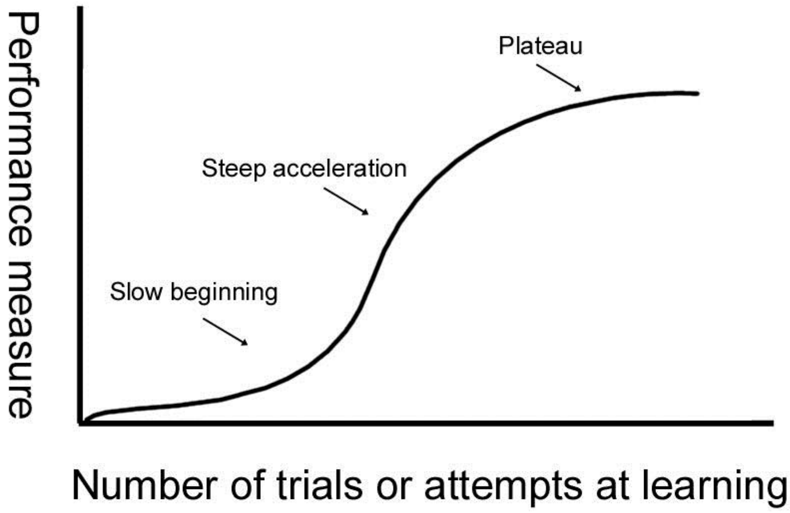

Figure 2.2: The motor learning curve (Fitts and Posner, 1967)

With the repetition of almost any motor task, learning occurs, and a person becomes more efficient at carrying out a task. In the mirror-tracing task, the tracing becomes more accurate. Progress in skill learning commonly follows an S-shaped curve, with the measure of skill on the Y-axis and the number of trials on the X-axis (Figure 2.2). Progress is slow at first, and then a subject may experience a burst of learning that produces a rapid rise on the graph. Many people believe that plateaus or flat periods during which a skill does not improve normally punctuate learning curves. However, the idea of a plateau as a temporary, stagnant period followed by more learning is a myth. Fitts and Posner (1967) found gradual improvement with practice in almost all motor skills. Motor learning curves may take various shapes. Initially, the learning effect rises quickly, then slows down and eventually reaches the plateau of motor learning. This curve shape is defined by different factors. A beginner first learns simple movements which are already known to him to some extent; the speed is low but the motivation for learning is high. Once the effect of these factors diminishes, the curve rises more slowly. Generally, it ends on a plateau: i.e. the phase where there is no longer any progress in learning (Schmidt, 1976a).

2.4 THE PHASES IN MOTOR LEARNING

The process of motor learning is long-lasting and, in terms of its effects, consists of three basic phases:

- the phase of basic movement coordination,
- the phase of accurate movement coordination; and
- the phase of movement coordination stabilisation under changeable and difficult circumstances (Čoh *et al.,* 2004).

2.4.1 The Phase of Basic Movement Coordination

In this phase of learning, an individual first learns about basic movements and is able to execute them only under favourable conditions and with sustained concentration. The results are quite modest as the technique is poorly developed and uneconomical. The notion of movement and motor sensations are vague, dull and incomplete – sometimes even wrong and not in harmony with the dynamic and temporal components of the optimal movement. A beginner is unable to distinguish between essential and less essential elements and phases of movement. As a rule, the initial notion is formed on the basis of the instructor's demonstration, a photo or a video recording. The so-called external sensory signal system (sight) engages and provides optical information. During this phase of motor learning, in addition to optical information, verbal information (the instructor's explanation) is also important; although it has to be clear, specific and comprehensible (Schmidt & Lee, 2005).

A beginner builds his basic notion of movement from visual and verbal information and thus creates the foundations for the execution of movement. When a beginner starts executing a movement, his central nervous system engages the motor memory which stores specific motor programmes – motor foreknowledge. In the process of learning more demanding motor tasks (tennis, skiing, golf, and gymnastics) these programmes are not very frequent in motor memory. Therefore, one must not be disappointed if one's first attempts are not successful. Of course, there are great differences between beginners, due to variances in their levels of motor foreknowledge and experience, motor abilities, mental concentration, motivation and endeavour (Harre, 1982; Piek,1998).

An important role is played by motor foreknowledge (motor programmes), which is indirectly connected to the elements of the technique in a given sport. According to Bernstein (in Latash, 1998), there is a strong transfer (transmission of motor knowledge and abilities) between related motor situations. For example, motor knowledge of gymnastics, track-and-field and tennis positively affects one's efficiency in learning to ski, play basketball and football, and vice versa. The more motor knowledge, experience and programmes a beginner has, the easier it will be for him to learn new movement techniques in other sports. In this phase a beginner often thinks that he is executing the task correctly, while in fact he is doing it perfunctorily or completely wrong. This is because his control over his movement is very weak. He is capable of controlling movement only through his visual signal system. The eyes may be the most important optical analyser but they are not enough.

The most important function in the coordination of movement is that of the kinaesthetic receptors. These are sensory bodies that are scattered over joints, ligaments and tendons and monitor body part position and movement, joint angles and muscle tension. In the case of beginners, the function of kinaesthetic analysers is substantially less prominent, as they depend on experience and the already mastered motor programmes and motor memory. Therefore, the feedback information flow is very weak; the information is incomplete, imprecise and untimely (Schmidt, 1991).

If one wants a beginner to understand verbal information (an explanation), one has to help him with optical control. The instructor has to clearly demonstrate technical elements, repeat them several times at a lower speed if needed, emphasise the key elements of execution and furnish a suitable explanation. As far as the explanation is concerned, care should be taken so that the beginner is only provided with the information that is indispensable for the execution of a specific movement. An abundance of initial information may negatively affect an individual's concentration and motivation.

The main characteristic of this phase of motor learning is rigidity of movement, manifested in the inability to distinguish between correct and incorrect movements, inadequate movement amplitude, stiffness and tension, inappropriate execution tempo and poor movement coordination (Huber, 2012).

The main reason lies in the phenomenon of "irradiation" in the motor cortex of the central nervous system (according to Bernstein, in Latash, 1998). The result is the uncontrolled activation of those muscles that are not engaged in specific movements. The engaged muscles and muscle groups work against each other and mutually hinder their performance. Furthermore, practicing leads to psychological and physical fatigue which eventually diminishes the learner's ability to concentrate on practising. Another element is often the fear of failure, which may additionally block the functions of the learning process. An enthusiastic beginner must not feel pressured to achieve success at any cost and to immediately attain his often unrealistic goals and ambitions. In this phase the instructor must not be overcritical; he should contribute positive energy and encourage the learner while correcting only critical errors. He must not bombard the learner with too much information. It is a known fact that a beginner may only control one or a maximum of two elements in an individual attempt at a movement (Schmidt & Lee, 2005).

In order to enjoy initial success in motor learning, the instructor has to take extenuating circumstances into consideration by offering assistance and reducing speed or force. At the same time, analysis of the playing technique has to be made in view of each individual's motor abilities. In many cases, errors stem from unsuitable motor abilities. Last but not least, a successful take-off in the learning process largely depends on a favourable working atmosphere that is manifested in mutual trust, motivation, a suitable environment, a favourable climate and temperature as well as the proper tools (Čoh *et al.,* 2004).

2.4.2 The Phase of Accurate Movement Coordination

During this phase an individual is capable of executing high-quality movement with regards to optimal technique pattern, provided that the circumstances are normal. Errors still occur but they are less obvious and less frequent. As the player repeats the movement, his results improve. Movement becomes more coordinated and individual motor phases are interconnected, leading to a good and refined movement coordination. Progress in learning the technique is not continuous and depends on the characteristics and abilities of an individual. After many very successful executions of a technique, a momentary standstill may occur that is usually of short duration. Performing incorrect repetitions may have long-term consequences, such as an unwanted consolidation of errors. The greater the number of error repetitions, the more the error becomes automatic and the harder it is to eradicate. This is why many "self-taught" tennis players, skiers, swimmers and golfers face great difficulties when learning with a professional instructor, as their motor memory stores incorrect notions of movement, incorrect motor programmes and resulting errors (Schmidt, 1977). In this situation, interference occurs when seemingly similar but essentially different programmes impede each other and cause disturbances that hinder the correct execution of the technique. Nevertheless, it is typical at this phase of motor learning that motor programmes are substantially more accurate and are connected primarily to kinaesthetic receptors. All three-signal systems, namely verbal, sensory and kinaesthetic, are more efficiently interconnected. As a whole, they form precise notions of movement in harmony with the external spatial and temporal coordinates. Movement is executed on the basis of a close coordination between what is desired and what is real. During this phase, anticipation of a movement distinctly improves, due to internal and external factors. The conscious control of movement subsides. The movement is executed "subconsciously" and subjectively with greater ease and relaxation. In addition to feedback, kinaesthetic and sensory control, an adequate cognitive and symbolic system is also set up at this phase (according to Bernstein, 1967; Latash, 1998).

An athlete translates concrete movements into ideas, terms or phrases, helping him to rationally control the movements and communicate better with the instructor. The athlete may be able to give minute descriptions of his own movements, individual phases and key moments. Kinaesthetic sensations become increasingly sharper and depend on changes in the environment and the tools. At this point, the methodology should focus on practising the technique in normal circumstances. Generally, a player scores better results in favourable conditions. Errors start appearing in difficult, unpredictable and changeable circumstances and cause the technique to collapse; possibly even producing long-term negative consequences on the game. The player and the instructor have to set a goal: execute the technique correctly, consistently and under standard circumstances (Čoh *et al.,* 2004).

2.4.3 The Phase of Stabilising Movement Coordination under Changeable and Difficult Circumstances

A learner is able to execute the optimal technique in changeable and difficult circumstances with a high level of stability. During this phase, the motor programme is completely automated and constant. Very subtle kinaesthetic sensations from the player are combined with verbal and sensory information. The level of the movement technique's applicability in a competitive environment is high. The motor programme is adapted to the player's abilities and characteristics and involves a high level of anticipation of movement and the possibility of correction. In addition to reliability and constancy, such a motor programme can easily be adapted to various unpredictable external and internal circumstances (Schmidt & Lee, 2005).

The player may execute the technique correctly despite some "distracting noises" such as psychological pressure, physical or psychological fatigue, competitive stress, wind, bad weather, etc. If the athlete's technique cannot adapt to such changes, it is completely useless. Therefore, methodology includes the execution of movements under difficult and changeable circumstances, constant control and correction. A high level of movement coordination has to be achieved through a flexible programme that adapts to external and internal changes. Only this kind of technique guarantees that the set goals will be achieved (Huber, 2012).

Experts have established that it takes between 40,000 and 50,000 repetitions of a certain motor task to achieve the complete stabilisation and automation of one's technique (tennis, skiing and golf). In this phase the method of practising the technique turns into a "training match" in which the simulation of competition circumstances and tactics is aimed at achieving the desired result. One of the most important components of learning and executing one's technique in competitive circumstances is concentration. In fact, concentration is a process which may last anywhere from only a few minutes to a few hours. An athlete has to focus on the execution of the movement and concentrate his thoughts in a pre-defined direction. The athlete should repeat the movement scheme in his mind several times (ideomotor training). In this way the movement pattern and motor memory will be consolidated (Singer, 1981).

The athlete should create conditions for positive thinking as well as a positive notion of the correct movement. Errors from the past have to be extracted from memory. "Bad movement patterns" have to be forgotten as soon as possible, as they reduce the player's self-assurance and confidence in his own abilities. Immediately before executing a motor task the athlete has to focus on one thing and remove all other thoughts. "There is no future and no past, there is only the present and myself." (Bernhard Langer – formerly one of the world's best professional golfers). High concentration consumes a lot of mental energy, which is limited at a certain level of a player's fitness. Players who are fitter are able to maintain high-powered concentration more easily and for longer periods of time (Glyn, 1992).

2.5 LEARNING METHODS

Learning methods are conventional procedures or sequences of procedures used for acquiring knowledge. In motor learning methodology, various learning methods are used and combined, depending on the exactness and character of the motor task and on the learner's age and stage of motor learning. The most important characteristic of a motor task, in terms of choosing the learning method, is its integration. The more the individual parts intertwine, the more significant the synthetic and combined methods are. If an individual is completely unfamiliar with the components of movement and considers them very demanding, the method of learning part-by-part is more appropriate (Marentič Požarnik, 2000).

2.5.1 The Method of Instruction

Verbal instruction is one of the most elementary forms of human expression and communication. It is important during the initial phase of motor learning, when an individual is becoming familiarized with the basic movements. It may include descriptions of the basic characteristics of movement, explanations of concepts, rules, inferences, definitions of models etc. An instruction may be in the form of a conversation, where questions and answers are not determined beforehand. It may also be a discussion, a debate or an argument where different opinions, viewpoints, attitudes, arguments and counter-arguments are put forward. When giving instructions, the instructor should present objective facts and adhere to the principle of gradual progress from: the easy to the more difficult; the familiar to the unknown; and the relevant and vital to the less important. Good instruction is the cornerstone of successful motor learning (Čoh *et al.,* 2004).

2.5.2 The Demonstration Method

The initial notion of motor learning is primarily based on a sensory signal system, which provides optical information (sight). The demonstration method has to be combined with other learning methods, especially the method of instruction. The demonstration must be absolutely correct, clear and suitable to the learner's age and level of maturity. The instructor must always evaluate the effect of the demonstration and its applicative value. The demonstration must be in line with the learner's mental and motor abilities, and suitable for practical application. The demonstration of only one ideal movement is not desirable. Movement technique mirrors the concrete effects of a learner's motor abilities and morphological characteristic with wide variety. The demonstration of a technique should reflect the general rules of movement and the comments should be based on the individual learner's limitations and particularities. The basic precondition for motor learning is a good mental and visual notion of movement, the activation of psychic processes and working muscles. The ability to create a notion of a motor task is primarily the function of the right hemisphere of the brain (Horst, 1985).

2.5.3 The Situational Method (Synthetic Method)

It is one of the most frequent and natural methods of motor learning and is usually used for less demanding movements. The method is more suitable and effective for beginners as they have a higher ability to understand movement as a whole rather than its individual parts.

The concept of learning movement as a whole is not to be understood literally, since learning is so demanding. In the case of complex movements, one should not start with all the details right away. In terms of difficulty and composition, not all movements are the same. Nevertheless, each movement has inherent basic and vital elements. Beginners have to learn these very basic elements as soon as possible. The situational method enables athletes to display their abilities and characteristics on two levels. The first consists of replication – repeating the motor task, which has been demonstrated in its entirety. The second level is the execution of a simple version of the motor task (a kind of imitation), while still considering the task as a whole. In both cases the instructor has to look for deficient movements and any gross errors. Minor errors may be "tolerated", and an extensive verbalisation is not recommended. In the case of beginners whose movement patterns (motor stereotypes) have not yet taken shape, the information is received and processed in an undifferentiated manner and at a lower level. However, it has to be emphasised that the emotional effects of such focused exercising are far greater, which may be a deciding factor – particularly at the beginning of the learning process. Strong inclination and an interest in exercising have a positive effect on learners' attention and motivation (Kaplan & Maehr, 2002).

2.5.4 The Analytical Method

The essence of this method is to divide the movement technique into individual fractions, teach these fractions one by one, and in the last phase, gradually combine the learned fractions with the basic movement. It is generally used for very complex movements, which cannot be learned as a whole. In this method, difficulties occur due to the long-term learning of certain fractions, and problems arise in the process of combining the learned fractions to form a whole. The overly repeated fractions, which sooner or later become automatic, may completely alter the overall movement scheme and rhythm. Therefore, the order of learning individual fractions is important. The basic movement scheme has to be preserved throughout the process. Experience shows that it is sensible to teach individual elements in the same order in which they appear in the kinematic and dynamic structures of the basic technique. Mastery of certain elements does not imply mastery of the entire movement. In principle, beginners are rarely taught by only this method. It is usually combined with some other method and the emphasis is put alternately on one or the other, depending on the learner's development, abilities and the degree of difficulty of the exercise. In practice, the analytical method is used during the initial phase of motor learning and then each well-mastered element is incorporated into the basic movement as soon as possible (Magill, 1993).

2.5.5 The Complex Method

This method is a combination of the situational and analytical methods. In motor learning both methods intertwine and complement each other. First, individual elements are practised. Then there is a gradual shift to practising the entire technique. Finally, some elements are practised again to achieve perfection. In the case of beginners, a stronger emphasis is placed on the situational exercise, while the analytical exercise is merely complementary. Irrespective of the applied method, care should be taken throughout the process so that the incorrect notions of movement do not consolidate and produce errors. Only a sufficient quantity of movements may produce an adequate quality of movements. It should be noted that there is no universal method to be applied under any circumstances and by anyone (Čoh *et al.,* 2004).

When applying any of the methods, the following has to be considered:

- The application of a learning method depends on biological and calendar age, foreknowledge, movement experience and information regarding movement;
- Attention has to be focused on the causes of incorrect movements, instead of their consequences;
- Causes of incorrect movements may be: incorrect notions, a lack of motor abilities (agility, strength, coordination), and an unfavourable morphological constitution;
- Gross errors have to be eliminated first, as the minor ones often stem from them;
- The sooner the errors are corrected, the lesser the chance of them becoming automatized;
- One-time errors should never be corrected if they occur by coincidence;

- Errors and shortcomings should be rectified in the order in which they appear;
- The correction process should not emphasise only the shortcomings, but also positive thinking, progress and trust;
- Instructions have to be in tune with the learners' motor sensations;
- Instructions have to be adapted to the learners' age and maturity;
- A variety of words, codes, illustrations, demonstrations and imitational exercises should be used to influence the movement patterns;
- The instructor should commend successful technique execution;
- The instructor should evaluate the technique from various angles and perspectives; and
- When correcting errors, the instructor should protect the learner's privacy and should never admonish a learner in front of his colleagues (Magill, 1993).

2.5.6 The Ideomotor Method

The basis of successful motor learning is a good notion of movement. When it comes to beginners, the notion of movement is vague, incomplete, sometimes even wrong and not in harmony with the real dynamic and temporal parameters of movement technique. A correct notion is formed on the basis of the instructor's explanation and demonstration. By means of visual and verbal information, a beginner can easily form a basic notion of movement and enhance it by the already existing motor programmes stored in his motor memory. In the ideomotor method, movement is performed inside one's mind, which makes it an example of mental learning. Only the motor cortex is activated and is responsible for the planning of motor structures. The athlete "executes" the movement technique in his mind – particularly the key elements of the technique. This method may be used in different situations. In the concentration phase, the athlete may take a mental leap and seemingly perform certain movement phases. The ideomotor method may help consolidate the movement pattern, as the number of imaginary repetitions is greater than the real movement frequency. Thus, the movement pattern consolidates because the memory traces before the next repetition are fresher and stronger. This method is highly effective, even when the athlete is injured, does not train and cannot execute the movement technique. Ideomotor training may help the athlete concentrate on the crucial moments of his performance. An athlete should be capable of "getting rid" of stress and competitive pressure and should prepare himself for the decisive moments of a competition (Marentič-Požarnik, 2000).

2.5.7 The Iterative Method

During the phase of automated and highly adaptable movement, when the athlete is able to execute optimal technique in changeable circumstances, the iterative method (Latin *iteratio* from *iterum* - repetition, doing anew) is one of the most common exercise methods. It involves repetition of a movement in a series over a period of short intervals. Each execution leaves a trace in the motor memory and paves the way for another trace. The effect of this method depends on the degree of technique automation, the athlete's motor abilities, movement complexity, the number of repetitions, and concentration and motivation. When applying this method, attention has to be paid to the correct technical execution of movement, otherwise the incorrect movements will become automated. The method is all the more successful when the movements are most similar to competitive technique elements. In the repetition process, breaks between the repetitions are highly important. If a break is too short, it can lead to mental and physical exhaustion or the learner might just start getting tired of that exercise. The pitfall of using this method is that it primarily activates the left hemisphere of the brain, which inhibits motivation and creativity. During this phase, feedback information about the correct execution of a motor task is of great importance. The instructor has to present the learner with as much criteria as possible so that the learner may evaluate his own performance independently. The control of movement is thus transferred from the instructor to the learner, where the learner develops a subtle feeling for execution accuracy. At this level, and by using this method, the instructor leaves the control of movement technique to the athlete, who has to rely on his inner feelings and feedback information. Of course it is recommendable for the athlete to compare his inner feelings with an objective recording of the technique e.g. video recording. The instructor's intervention in this phase is only necessary when serious errors in movement are identified. Errors may occur unexpectedly, owing to fatigue, lack of concentration, a hidden injury or the athletes' getting tired of training. This is why the instructor has to have professional knowledge, practical experience and the ability to analyse movement, while at the same time giving the athlete the right information at the right time and in the right place (Huber, 2012).

2.6 FACTORS THAT INFLUENCE LEARNING

In the past, motor learning theories focused on descriptions of movement organization, stressing the coordination of the neuromuscular systems that control movements (Adams, 1971, 1977; Schmidt, 1975; Arbib, 1985). From this perspective evolved the theory that movement patterns are stored in memory as a schema or an abstraction of the general characteristics of a movement (Schmidt, 1975). However, Schmidt (1987) refers to the schema as a generalized motor program that serves as the memory representation for a class of movements, rather than for any one action or movement. A movement class is defined by the invariant characteristics of actions. Invariant characteristics are "…aspects of movements that appear to be fixed even though other, more superficial features can change" (Schmidt, 1987: 266). When a group of actions have common invariant characteristics, they are considered to be in the same movement class and are therefore represented in and controlled by the same generalized motor program. For example, signing one's name is a generalized motor program. Whether one signs on paper or on a blackboard, using hands or feet, the guiding rules in this action are identical. The pattern of the signature or the shapes of the letters – which will be similar in any of these actions – are invariant, yet the size of the letters and the specific muscles used vary. Several different movement characteristics have been proposed to be the invariant characteristics of a motor program, such as the relative timing of the components of the action, the relative force produced by the components of the action, the sequence of events involved in the action (Schmidt, 1987), and spatial configurations (Bernstein, 1967). Currently, however, there is no general consensus concerning the characteristics of motor programs (Gentner, 1987, 1988; Heuer & Schmidt, 1988; Heuer, 1988). Furthermore, the generalized motor program theory has been criticized for its failure to prove the existence of additional invariant features (Horak, 1991; Poole, 1991). From Schmidt's (1975; 1987) viewpoint, the strength of a generalized motor program is directly related to the variability in practice of different tasks that belong to the program's movement class. For example, practicing the transfer to different types of chairs allows the client to practice the motor program of transferring to a chair, whereas the timing of the action, the force produced by the muscles during the motion, and the size of the motion (the spatial configurations) differ according to the width, height, and shape of the chairs. Hence, Schmidt (1976a) predicts that variability in practice is beneficial for retention and transfer of a motor skill. Catching balls of varying size or grasping objects of different shapes are two other examples of variable practice. Studies investigating the effects of practice variability (Newell & Shapiro, 1976; McCracken & Stelmach, 1977; Magill & Reeve, 1978; Wrisberg & Ragsdale, 1979; Kerr, 1982) compare constant practice of a single task to variable practice in either a predictable or unpredictable presentation order. Studies in which variable practice tasks are presented in a predictable order found limited support for the theory that variability enhances retention and transfer (Newell & Shapiro, 1976; Magill & Reeve, 1978; Kerr, 1982). Studies in which variable practice is presented in an unpredictable order (McCracken & Stelmach, 1977; Wrisberg & Ragsdale, 1979; Csikszentmihalyi, 2014), however, does support the theory.

2.6.1 Environmental factors

Environmental factors influence motor learning; the therapist/educator must consider the nature of the environment because different environmental factors elicit different motor reactions (Gentile, 1972, 1987). To be successful, movements should correspond with certain factors of the environment. For example, the movement of picking up a cup to drink must be adapted to the environmental factors of the shape of the cup, its distance from the person, and the volume of liquid. The object, in this case the cup, determines the spatial arrangement of the movement. In some cases, timing of the movement is important, such as in the act of catching a ball. The goal of the action determines the environmental factors (regulatory conditions) that are critical for performance (Gentile, 1972, 1987). Motor skills may be classified according to their spatial and temporal environmental factors (Gentile, 1972, 1987). When temporal environmental factors are stationary, only the spatial factor of the movement is controlled by the environment. For example, the spatial factors of picking up a newspaper are different for lifting a Sunday newspaper than for lifting a weekday newspaper. Timing is not specified – lifting the paper is a self-paced action. Tasks in which temporal environmental factors remain stationary and fixed from trial to trial are termed "closed tasks". Tasks in which the temporal factors of the environment are stationary but the spatial factors of the task, such as the size or location of objects, vary from trial to trial, are called "variable motionless tasks". These include walking on different surfaces, picking up a cup from different locations on a table, and buttoning a shirt with different types of buttons. When environmental factors include objects or persons that are moving, the environment determines both spatial and temporal factors of the movement. For example, when catching a ball or stepping onto an escalator, a person needs to predict where the object will be. Tasks in which these environmental factors change from trial to trial are termed "open tasks". For some tasks, the pace of the movement is constant while the environment is moving. These tasks, termed "consistent motion", are associated with mechanical devices such as escalators and assembly line belts. Skill acquisition, according to Gentile (1972, 1987), involves two stages:

(a) trial and error: the movement is not consistent; and

(b) task dependent: the four types of tasks are learned differently and therefore should be taught differently.

As practice progresses in closed and consistent motion tasks, movement patterns are refined and retained. The movement pattern should become consistent because the environmental conditions are static (Higgins & Spaeth, 1972; Hobart *et al*., 1978). Therefore, Gentile (1972, 1987) recommends using a predictable environment to teach persons to develop a consistent motor pattern in response to stationary input. As practice progresses in the open and variable motionless tasks, movement patterns should diversify. The client/learner must respond to the varied environmental stimuli (Higgins & Spaeth, 1972; Hobart *et al*., 1978). Therefore, Gentile (1972, 1987) recommends teaching open and variable motionless tasks in an unpredictable, changing environment to develop diversification of the motor pattern.

2.6.2 Cognitive Processes

Motor learning theories have been criticized for their tendency to focus on internal neuromuscular movement organization while underestimating the importance of cognitive processes in retention and transfer of motor behaviour (Battig, 1979; Lee & Magill, 1983; Salmoni *et al*., 1984).

Learning theory suggests that skill acquisition in unpredictable environmental conditions is beneficial for memory and transfer (Craik & Lockhart, 1972; Battig, 1979; Tulving, 1979; Shea & Zimny, 1983). Battig (1979) claims that presenting several motor tasks together in certain contexts can facilitate cognitive processes beneficial to memory improvement. He terms the difficult learning context, such as an unpredictable situation, a context with high contextual interference. Performing a motor task in a difficult learning context forces the client/learner to use multiple and variable processes to overcome the difficulty of practice (Battig, 1979; Shea & Zimny, 1983). Despite its slowing of the acquisition phase, performing in a difficult context leads to the development of more elaborate and distinctive memory representations of the movements practiced; which is beneficial for retention (Battig, 1979; Shea & Zimny, 1983).

The educator can create high contextual interference by presenting trials of several tasks in a random order. That is, if each task is assigned a different letter, the order of tasks might be ABACBACABBC. For example, random practice with transferring to a chair would involve introducing a different chair to the client in different trials. Lee *et al*. (1985) suggests that the presentation of motor tasks in an unpredictable context causes the client to forget certain aspects of the way he/ she performed the tasks before. The time lapse between the presentations of different tasks (e.g., different chairs) causes the client to forget the way he or she performed the movements before, forcing the client to reconstruct movements for each subsequent attempt. As a result, further practice is imposed on the client, which facilitates retention.

Several studies support this “reconstruction” view (Lee & Magill, 1983, 1985; Magill *et al*., 1992; Shea & Wright, 2001). The findings of Del Rey *et al*. (1987) do not support Lee and Magill's (1983, 1985) explanations, because the interfering activity they used to facilitate this type of “forgetting” did not influence retention or acquisition. The easy learning context, termed “one with low contextual interference”, such as a predictable situation, does not force the client to use elaborate encoding processes, leaving weaker memory representations of the movements practiced (Battig, 1979;

Shea & Zimny, 1983). As a result, though low contextual interference may speed the process of acquiring a skill, it does not help retention to the same extent as high contextual interference. Low contextual interference can be created by presenting tasks in a blocked order, so that practice of the first task must be completed before the client/learner advances to the second task, and so on… (i.e., AAABBBCCC). For example, in the activity of transferring to a chair, the client would practice transferring to a specific chair repeatedly until that task was mastered. Only then would the client practice transferring to another type of chair, and so on (Jarus, 1988).

The feedback given to the client about the consequences of a movement, such as the extent to which the intended goal was achieved, can be referred to as "knowledge of results" (Sage, 1984; Schmidt, 1987). Knowledge of results can be telling the client, "You burnt the egg," "You put the peg in the right hole", "You missed the target by 2cm", or "You buttoned your shirt wrong". Jarus (1988) and Lee and Magill (1983) suggest that the effect of the level of knowledge of results during the acquisition phase may be similar to the effect of high contextual interference. Several studies have found that clients given constant knowledge of results in the acquisition phase do not do as well in the retention phase, when knowledge of results is eliminated, as do clients/learners given less frequent knowledge of results in the acquisition phase (Baird & Hughes, 1972; Ho & Shea, 1978; Jarus 1988, Schmidt *et al*., 1989; Wulf & Schmidt, 1989; Winstein & Schmidt, 1990). Schmidt (1987) states that knowledge of results can be viewed as a crutch that guides performance. Under conditions with limited knowledge of results, the client is forced to rely on other relevant cues of the task – such as sensory feedback – to improve performance (Salmoni *et al*., 1984; Schmidt, 1987). The client can subsequently perform the acquired task without knowledge of results. This reasoning is consistent with the contextual variety hypothesis (Battig & Shea, 1978). That is, predictable practice in a blocked order, or with constant knowledge of results, is beneficial for acquisition, yet detrimental to retention. Unpredictable practice in a random order, or with less frequent knowledge of results, is detrimental to acquisition, but beneficial for retention and transfer. Thus, the level of contextual interference and the level of knowledge of results during acquisition of motor skills influence the abilities to retain the learned material and perform a transfer task (Battig, 1979; Magill & Hall, 1990).

2.6.3 Developmental problems

There are certain stages of growth and development that are common to most children. This results in a child passing through stages in approximately the same order and at the same age as another. Cheatum and Hammond (2000) believe that careful examination of the stages of development might reveal that a child, at some point experienced certain developmental difficulties that are impacting on or limiting his/her academic or motor abilities. Motor development follows a hierarchical pattern, which entails certain qualitative changes in motor behaviour. It also proceeds in a sequential fashion as a result of the growth and development of the central nervous system (Csikszentmihalyi, 2014).

Gross motor skills (walking, running) develop before fine motor skills (for example, handwriting and bead threading). The order in which the sequence is reached seems to be recognizable. However, not all children reach these stages at the same time or in the same length of time. Each child is unique and will move through the developmental stages at an age that suits him or her (Piaget & Inhelder, 1973).

Kokot (2006) states that children who experience trouble with their sensory systems also usually have one or more developmental problems or delays, which impact their academic achievements. The sensory system is an interrelated system without which the body cannot function. Sensory awareness is learnt very early in life and an understanding of the sensory system and how it relates to movement is of importance for this study. The sensory system (vestibular, proprioception, tactile, visual and auditory) along with gustatory (taste) and olfactory (smell) form the full complement of ways through which information can reach the central nervous system (CNS).

2.6.3.1 The Vestibular system

This provides the foetus with a sense of direction and orientation in the womb as well as to help the child cope with gravity once he/she is born. The result is that before a child enters the world he/she should have an efficiently functioning vestibular system (Goddard, 2002; Kokot, 2006).

The vestibular system is considered to have the most important influence on other sensory systems and on the child's ability to function in everyday life. According to Seaman *et al.* (2003) and Kokot (2006), the vestibular system provides widespread influence throughout the CNS and contributes to the coordination and timing of all sensory input for the enhancement of perception and physical development.

The overall function of the vestibular system is to communicate a sense of spatial awareness of the body and to maintain the posture and balance that is required of the individual to be able to perform motor activities. The vestibular receptors provide information to an individual whether one is moving fast or slow, maintaining balance against the pull of gravity, moving or having the room move, whether one's head is rotating, or the body is bending or remaining static. It also helps the child to know if he/she is sitting upright or falling off the chair (Cheatum & Hammond, 2000; Winston 2004; Kranowitz, 2005)

Problems in the balance system will have repercussions for all other areas of functionality, such as muscle tone, ocular muscle control and proprioceptive control. These problems affect the sensory motor systems, because all the sensations pass through the vestibular system at brainstem level before they are transmitted elsewhere in the brain for analysis (Goddard Blythe, 2002; Kranowitz, 2005).

Muscle tone is controlled by the vestibular system and it is considered to be the amount of tension normally visible when the muscles are in a restating state. Muscle tone is required to control posture. This includes the strength needed to sit in a chair, attempt to hold the neck steady for reading and writing, or compete in sport or recreational activities. According to Kokot (2006), it is often taken for granted that the child has automatic control of the skeletal muscles in order to sit or stand still. Other requirements a child needs are to be able to stabilise the body to move an arm, leg, hand or foot independently during fine and gross motor activities.

Pyfer in Goddard Blythe (2002:59) acknowledges the impact of the proper functioning of the vestibular system on motor development as follows: "Vestibular input is necessary for static and dynamic balance development, eye tracking ability and motor planning; children who are slow to develop good vestibular functioning are delayed in all gross motor patterns which require coordination of both sides of the body. They have difficulty in maintaining posture, with eye-hand coordination and with fine motor control."

2.6.3.2 The proprioceptive system

Kranowitz (2005) notes that "proprio" means "one's own" in Latin. It is the body's "internal eyes" which give information regarding where the body is or body parts are in space, how our body parts relate to one another, how much and how quickly our muscles are stretching, how fast our body is moving through space, how effective our timing is, and how much force our muscles put forth. Hannaford (2005, 2007) describes proprioception as the body's sense of itself in space; it is one of our most important means of knowing. All the muscles have proprioceptive receptors, which inform the body about its physical position and provide feedback necessary for a person to move and maintain balance.

Cheatum and Hammond (2000) add that proprioceptive refers to the actual awareness of sensations that come from receptors in the muscles, joints, skin, tendons, and underlying tissue. Seaman *et al.* (2003) elaborate by stating that the proprioceptive system detects pressure and vibration such as pushing, pulling or squeezing. This system has tremendous importance to motor development in that it is critical to the motor action of reflexes, automatic responses, and planned movement.

Proprioception is necessary for the development of body schema. Body schema evolves through neuromuscular information, which is sent to the CNS during static and dynamic movements. A child's body schema is an internal awareness or map, of the relationship of the body and body parts to each other. Without body schema there is little hope that the child can progress through the developmental stages of laterality, directionality and directional discrimination (Krog, 2010).

2.6.3.3 The tactile system

This system enables children to help distinguish between, and orientate themselves with environments, so that they know that they are touching and what texture the objects or surfaces consist of.

Hannaford (2005) states that the skin is the largest organ of the body, which is equipped with nerve sensors for light, touch, pressure, heat, cold, pain and proprioception. According to Kranowitz (2005), the tactile system receives sensations of pressure, vibration, movement, temperature, and pain primarily through receptors in the skin and hair.

The responsibility of the tactile system is to help the child to tell the difference between the moisture of the skin and the texture, shape, size, weight of objects when held in their hands. It allows the child to determine if clothing is comfortable, scratchy, or tight, light or heavy. The child is also able to determine if something is uncomfortable or whether he or she enjoys people standing close or not; in other words, if their touch is pleasant or not (Cheatum & Hammond, 2000).

The child's reaction to touch could be one of flight or fight. A child may thus be either *insensitive* to touch or *oversensitive* to touch. Insensitivity may lead to an inability to localise touch on the body – to be insensitive to pain or temperature. Children who are highly sensitive to touch are referred to as having *tactile defensiveness.* These children perceive touch as irritating and painful. These children feel uncomfortable in their bodies and tend to move a lot (Cheatum & Hammond, 2000; Goddard Blythe, 2002; Kranowitz, 2005).

2.6.3.4 The auditory system

This system is the hearing sense, which receives stimuli through the ear. We are born with the basic skill of hearing. We cannot learn how to hear, either we hear or we do not. It connects with muscles throughout the body helping it to regulate equilibrium and coordination (Kranowitz, 2005).

According to Van der Westhuizen (2007), the auditory system helps control balance, body movement and coordination. A large number of the sensory messages received by the brain are received via the ears. The ears also play a part in helping to control one's eyes when one reads and one's arm, hand and fingers when one writes.

Miller (2006) explains that the vestibular and the auditory systems both work together as they process sensations of movement and sound. The profound influence of the ear on physical development is acknowledged. Not only is it vital for hearing, balance and flexibility but also for bilateral coordination, breathing, speaking, vision, social relationships as well as academic learning.

2.6.3.5 The visual system

Vision is complex and the most dominant sensory system for learning more about where we are and what is happening around us. Visual perception is not eyesight and a child can either see or not see. Vision has to be developed by integrating the senses. Vision is developed through movement. Movement is the basis of all learning, it teaches the eyes to make sense of sights. Whereas a child sitting in front of the computer or sitting still to read is not developing vision (Ayres & Robbins, 2005).

Kranowitz (2005) explains the link between the vestibular and proprioceptive systems as having a profound influence on vision. While sitting, standing on two feet, or lying down, sensations bombard the brain and facilitate eye movements. If we move around, switch directions or change our body, head or eye position, our visual skills are strengthened. Engaging in purposeful activities helps the eyes become coordinated. Movement, balance, muscle control, and postural responses are core ingredients for proper vision development.

All senses are required in order to develop vision. The tactile sense has a huge effect on vision; for example a child sees a ball, picks it up and holds it with both hands. The following day he/she sees another ball and knows it's round, smooth and solid. This information builds visual images in the brain. Auditory senses affect vision in the same way. On hearing the door slam, the child will turn in the direction and see the source of the sound (Miller, 2006).

2.6.4 The reflex system

Reflexes initiate motor development during the first two years of life, thereafter motor development depends largely on a child progressing through the series of primitive reflexes, postural reflexes and voluntary movements. Every child is born with a set of reflexes, which are important for his/her survival, and forms the basis of the reflex system. The process of normal development depends on the emergence, inhibition and in certain instances, transformation of the primitive reflexes, so that postural reflexes may be released – in order to prepare the child for progressive development. Reflexes emerge in utero and should be inhibited or in certain cases transformed by a higher part of the brain. If this fails to happen, the reflexes remain aberrant and represent a structural weakness in the CNS (Goddard Blythe, 2002).

A child with aberrant reflexes (reflexes still present) may show impaired functioning in specific areas. This dysfunction may be barely detectable but as the stressors become greater, the compensatory mechanisms start to break down and the weakness becomes more visible. Difficulties may be seen in the form of symptoms, which range from clumsiness and ambidexterity, to learning and emotional disorders (Goddard Blythe, 2002; Kokot, 2006). Reflexes form part of a main highway of connections from the motor cortex to the muscles. Ignoring the possible influences of retained reflexes within a movement programme has proven to be problematic to learning readiness.

Table 2.2: Influence of the five basic sensory systems on learning (Goddard Blythe & Hyland, 1998; Cheatum & Hammond, 2000; Clark Brack, 2004; Kranowitz, 2005)

Symptoms of vestibular problem	Symptoms of children who are insensitive to touch
Reported preference for quiet activities (a couch potato). Complaints of dizziness or nausea. Frequent loss of balance. Difficulty sitting still. General clumsiness. Seeking out spinning activities. Avoiding certain movements. A pallid or flushed skin after certain movements. Low muscle tone. Car sickness. Poor directional awareness. Difficulties in space perception. Poor organizational skills. Dizzy behaviour, literally meaning scatter-brained.	Cannot identify body parts. Has poor spatial awareness. Lacks body schema. Lacks desire to participate. Has poor body image. Shows poor posture. Appears clumsy. Is unable to adjust body to the tasks it faces. Does not show refined movements. Seeks physical contact. Has poor motor planning. Has poor balance skills. Has poor gross motor skills. Lacks laterality and directionality. Has poor awareness of left and right. Has trouble finding his way around shopping malls or school. Shows poor motor skills. Has trouble using scissors. Has trouble using crayons. Lacks ability to discern shapes, textures and weights.

Table 2.2: Influence of the five basic sensory systems on learning (Goddard Blythe & Hyland, 1998; Cheatum & Hammond, 2000; Clark Brack, 2004; Kranowitz, 2005) (cont.)

General symptoms of proprioceptive problems	Common tactile-defensive symptoms seen in the child, on the playground or in the classroom
Poor naming and locating of body parts. Poor balance, both static and dynamic. Problems with fine motor skill, cutting, colouring, and so on. Appears not to know when he is touching others. Uses either hand to write, colour, throw, and so on. Poor posture and muscle tone. Uses either foot to kick. Problems with gross motor skills, such as running and jumping. Difficulty learning to dress himself. Has splinter skills and cannot transfer them to related skills or activities. No left and right awareness. Has no memory of past instructions involving motor skills. Cannot coordinate the use of his eyes. Midline problems cause lack of coordination between the two sides of the body. Cannot use two hands together for skills. Cannot tell directions; gets lost easily. May run into furniture, walls, or other people. Has no awareness of up and down, before and after. Immature loco-motor patterns for walking. Poor awareness of space. Prefers to play with younger children.	Dislikes tag games. Avoids somersaults. Hates being hit or tagged with a ball. Avoids most stunts with other children. Avoids sitting on grass or rough carpet squares. Prefers to be alone. Cries when made to get into the water for swimming. Does not like to towel dry. Dislikes tug-of-war games. Socks always feel uncomfortable. Tries to stay at the end of a line of children. Hates having dirt on body or hands. Avoids standing in lines. Does not like rolling. Prefers loose-fitting clothes. Responds with fighting when touched from behind. Responds to someone's touch by hitting. Dislikes contact sports. Complains about certain clothes. Is considered a troublemaker or aggressive.

Table 2.2: Influence of the five basic sensory systems on learning (Goddard Blythe & Hyland, 1998; Cheatum & Hammond, 2000; Clark Brack, 2004; Kranowitz, 2005) (cont.)

Possible visual dysfunctions	Symptoms of possible auditory dysfunction
Poor eye contact. Turning head to the side to read or look at things. Holds head very close to work. Stomach aches after reading or visual work. Difficulty copying from the board. Difficulty tracking a ball to catch. Loses place on page when reading. Blinks eyes a lot. Rubs eyes after visual work.	Covers ears or scream with sudden loud noises. Has difficulty locating sound. Enjoys constantly making sounds (e.g. humming). Is easily distracted by background noises. Prefers very loud music. Delayed language development. Dislikes crowds and noisy environments. Asks for repetitions of words and conversation. Difficulty falling asleep or staying asleep if there is any noise. Delayed and laborious decoding of reading.

2.7.1 Motor Control Functions of the brain

Almost all of behaviour involves motor function, from talking, to gesturing, to walking. But even a simple movement like reaching out to pick up a glass of water can be a complex motor task to study. Not only does your brain have to figure out which muscles to contract and in which order to steer your hand to the glass, it also has to estimate the force needed to pick up the glass. Other factors, like how much water are in the glass and what material the glass is made from, also influence the brains calculations. Not surprisingly, there are many anatomical regions, which are involved, in motor function (Schwerin, 2013).

Delacato (1966) explains neurological organizations as deficits in readiness and shows how a child develops physically and neurologically in his early years and ultimately, intellectually. Neurological organization describes the process of activities control that begins at the level of the spinal cord the medulla, at birth, then goes to the pons, to the midbrain and finally to the cortex. This organization terminates when the child is approximately six to eight years of age. In other words, the neurological development process is complete at this time.

The primary motor cortex (M1) lies along the precentral gyrus, and generates the signals that control the execution of movement. Secondary motor areas are involved in motor planning. The plane of this section is elaborated in Figure 2.3b.

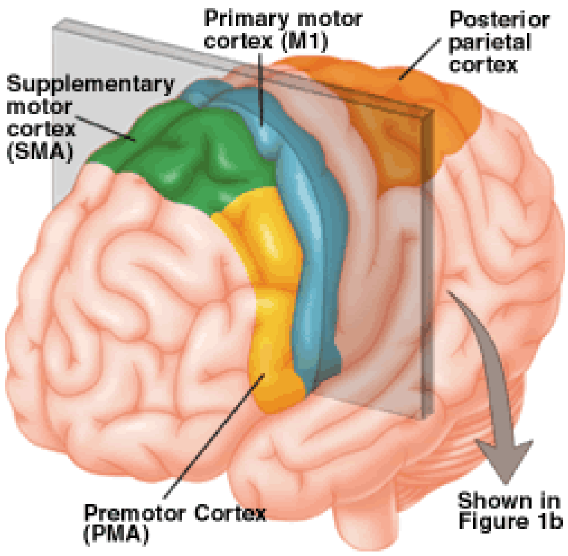

Figure 2.3a : Principal cortical domains of the motor system
(http://brainconnection.brainhq.com).

The primary motor cortex, or M1, is one of the principal brain areas involved in motor function. M1 is located in the frontal lobe of the brain, along a bump called the precentral gyrus (Figure 2.3a). The role of the primary motor cortex is to generate neural impulses that control the execution of movement. Signals from M1 cross the body's midline to activate skeletal muscles on the opposite side of the body, meaning that the left hemisphere of the brain controls the right side of the body, and the right hemisphere controls the left side of the body. Every part of the body is represented in the primary motor cortex, and these representations are arranged somatotopically — the foot is next to the leg, which is next to the trunk, which is next to the arm and the hand. The amount of brain matter devoted to any particular body part represents the amount of control that the primary motor cortex has over that body part. For example, a lot of cortical space is required to control the complex movements of the hand and fingers, and these body parts have larger representations in M1 than the trunk or legs, whose muscle patterns are relatively simple. This disproportionate map of the body in the motor cortex is called the motor homunculus (Figure 2.3b) (Roland *et al.,* 1980; Schwerin, 2013).

A figurative representation of the body map encoded in primary motor cortex. The section corresponds to the plane indicated in Figure 2.3a. Body parts with complex repertories of fine movement, like the hand, require more cortical space in M1, while body parts with relatively simpler movements, like the hip, require less cortical space (Campbell, 1905).

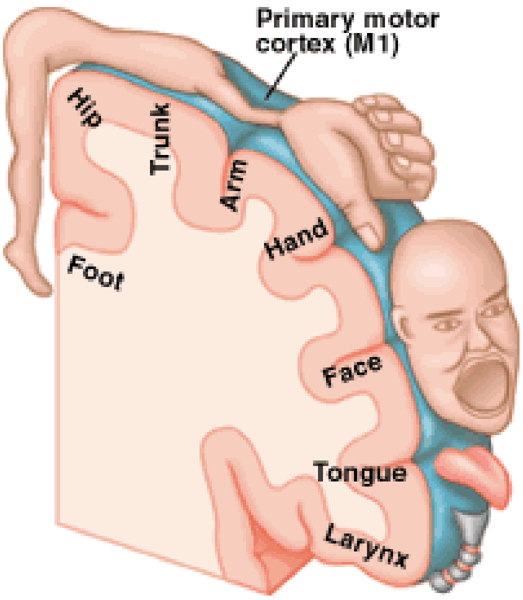

Figure 2.3b: The motor homunculus in the primary motor cortex.
(http://brainconnection.brainhq.com)

Other regions of the cortex involved in motor function are called the secondary motor cortexes. These regions include the posterior parietal cortex, the premotor cortex, and the supplementary motor area (SMA). The posterior parietal cortex is involved in transforming visual information into motor commands. For example, the posterior parietal cortex would be involved in determining how to steer the arm to a glass of water based on where the glass is located in space. The posterior parietal areas send this information on to the premotor cortex and the supplementary motor area. The premotor cortex lies just in front of (anterior to) the primary motor cortex. It is involved in the sensory guidance of movement, and controls the more proximal muscles and trunk muscles of the body. In our example, the premotor cortex would help to orient the body before reaching for the glass of water. The supplementary motor area lies above, or medial to, the premotor area, also in front of the primary motor cortex. It is involved in the planning of complex movements and in coordinating two-handed movements. The supplementary motor area and the premotor regions both send information to the primary motor cortex as well as to brainstem motor regions (Schwerin, 2013).

Neurons in M1, SMA and premotor cortex give rise to the fibres of the corticospinal tract. The corticospinal tract is the only direct pathway from the cortex to the spine and is composed of over a million fibres. These fibres descend through the brainstem where the majority of them cross over to the opposite side of the body. After crossing, the fibres continue to descend through the spine, terminating at the appropriate spinal levels. The corticospinal tract is the main pathway for control of voluntary movement in humans. There are other motor pathways, which originate from subcortical groups of motor neurons (nuclei). These pathways control posture and balance, coarse movements of the proximal muscles, and coordinates head, neck and eye movements in response to visual targets. Subcortical pathways can modify voluntary movement through interneuronal circuits in the spine and through projections to cortical motor regions (Campbell, 1905).

The spinal cord is comprised of both white and grey matter. The white matter consists of nerve fibres traveling through the spine. It is white because the nerve fibres are insulated with myelin for faster conduction of signals. Like many other large fibre bundles, the corticospinal tract courses through the lateral white matter of the spine. The inside of the spinal cord contains grey matter, composed of the cell bodies of cells including motor neurons and interneurons. In a cross-section of the spinal cord, the shape of the grey matter resembles a butterfly. Fibres in the corticospinal tract synapse onto motor neurons and interneurons in the ventral horn of the spine. Fibres coming from hand regions in the cortex end on motor neurons higher up in the spine (in the cervical levels) than fibres from the leg regions, which terminate in the lumbar levels. The lower levels of the spine therefore have much less white matter than the higher levels (Calais-Germain, 2007).

Within the ventral horn, motor neurons projecting to distal muscles are located more laterally than neurons controlling the proximal muscles. Neurons projecting to the trunk muscles are located the most medially. Furthermore, neurons of extensors (muscles that increase the joint angle such as the triceps muscle) are found near the edge of the grey matter, but the flexors (muscles which decrease the joint angle such as the biceps muscle) are more interior. It is important to note that a single motor neuron in the spine can receive thousands of inputs from the cortical motor regions, the subcortical motor regions and also through interneurons in the spine. These interneurons receive input from the same regions and allow complex circuits to develop (Calais-Germain, 2007; Schwerin, 2013).

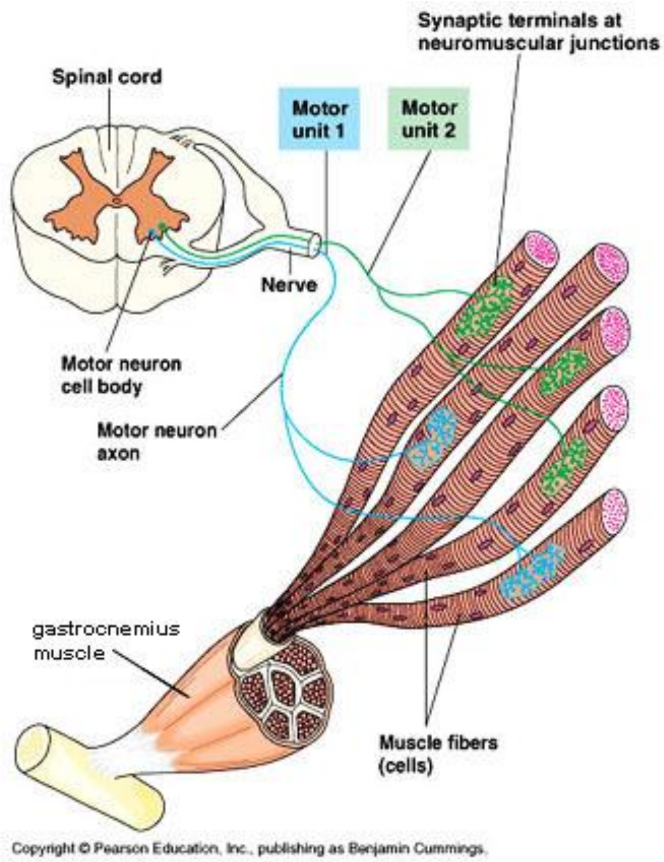

Figure 2.4: Motor Unit (Shapiro, 2009)

Signals generated in the primary motor cortex travel down the corticospinal tract through the spinal white matter to synapse on interneurons and motor neurons in the spinal cords ventral horn. Ventral horn neurons in turn send their axons out through the ventral roots to innervate individual muscle fibres. In this example, a signal from M1 travels through the corticospinal tract and exits the spine around the sixth cervical level. A peripheral motor neuron relays the signal out to the arm to activate a group of myofibrils in the bicep, causing that muscle to contract. Collectively, the ventral horn motor neuron, its axon, and the myofibrils that it innervates are called a single "motor unit" (Roland *et al.,* 1980).

Each motor neuron in the spine is part of a functional unit called the motor unit (Figure 2.4). The motor unit is composed of the motor neuron, its axon and the muscle fibres it innervates. Smaller motor neurons typically innervate smaller muscle fibres. Motor neurons can innervate any number of muscle fibres, but each fibre is only innervated by one motor neuron. When the motor neuron fires, the entirety of the muscle fibres contract. The size of the motor units and the number of fibres that are innervated contribute to the force of the muscle contraction (Campbell, 1905).

There are two types of motor neurons in the spine, "alpha" and "gamma" motor neurons. The alpha motor neurons innervate muscle fibres that contribute to force production. The gamma motor neurons innervate fibres within the muscle spindle. The muscle spindle is a structure inside the muscle that measures the length or stretch of the muscle. The Golgi tendon organ is also a stretch receptor, but it is located in the tendons that connect the muscle to the skeleton. It provides information to the motor centres about the force of the muscle contraction. Information from muscle spindles, Golgi tendon organs and other sensory organs are directed to the cerebellum. The cerebellum is a small grooved structure located in the back of the brain beneath the occipital lobe. This motor region is specifically involved when learning a new sport, dance step or instrument. The cerebellum is involved in the timing and coordination of motor programs. The actual motor programs are generated in the basal ganglia. The basal ganglia are several subcortical regions that are involved in organizing motor programs for complex movements. Damage to these regions result in spontaneous, inappropriate movements. The basal ganglia send output to other subcortical brain regions and the cortex (Schwerin, 2013).

Through the interaction of many anatomical motor regions, everyday movements seem effortless and more complex movements can be learned.

2.7.2 The central nervous system

Movement originates in the brain and the central nervous system and it is influenced by their functioning. Every movement that a person experiences is controlled by the nervous system (Figure 2.5). The nervous system is made up of the brain, spinal cord and a network of nerves, which forms the body's control center. The brain works out which movements the body needs to make and in which particular order they need to follow. The message is then sent out to the muscles through the nerves. The nervous system takes the longest of all the body's systems to develop fully (Macnair, 2005).

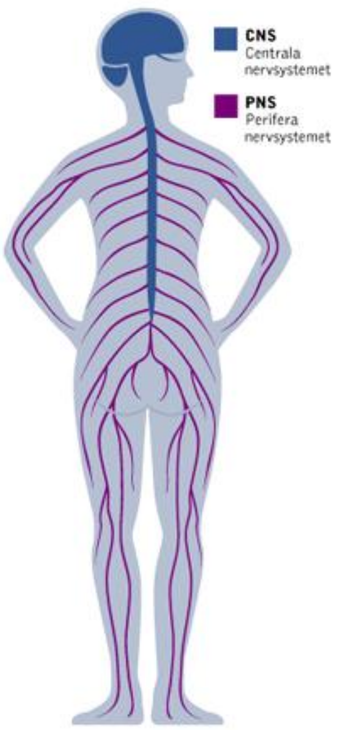

Figure 2.5: Nervous system

(http://blog.lib.umn.edu/nich0185/myblog2/2012/01/biological-psychology.html)

The nervous system's role is to pass messages from one part of the body to another. It consists of nerve endings, which reach into all parts of the body. The nervous system is divided into three parts, namely the central nervous system (CNS), the peripheral nervous system (PNS) and the autonomic nervous system (ANS). The *central nervous system* consists of the brain and the spinal cord. The spinal cord – which runs along the inside of the backbone – acts as a pathway, carrying millions of nerve impulses between the brain, the limbs and the trunk. The central nervous system governs prenatal and early developmental reflexes as well as reactions that are involuntary (Cheatum & Hammond, 2000).

Forty-three pairs of nerves branch from the CNS: twelve come from the brain and thirty-one from the cord. These divide and snake among the organs and tissue, and filter into every tiny nook and cranny to form the peripheral nervous system (Walker, 2003; Hall, 2005; Parker, 2007).

The *peripheral nervous system* consists firstly of all the sensory nerves which feed information into the spinal cord and brain. These sensory nerves contain sensory neurons. Secondly, the peripheral nervous system consists of the motor nerves, which carry messages to other parts of the body from the brain and spinal cord. Motor nerves contain motor neurons and mixed nerves contain both sensory and motor neurons. Sensory neurons are usually connected to motor neurons by intermediate neurons (also known as inter neurons). Sensory, intermediate and motor nerves have gaps between them called synapses (Parker, 2007)

Walker (2003) elaborates on the three types of neurons. Firstly, the *sensory neurons* are triggered by physical stimuli, such as light. Secondly, a*ssociation neurons* are triggered by sensory neurons, which process the information from the sensory neurons, which then issue outgoing commands. Commands are then passed on to the third type of neuron, *motor neurons* which assist parts of the body to respond (Figure 2.6).

Cheatum and Hammond (2000) point out that the PNS helps a child use the correct motor skill for a particular movement. In order for a child to write on a piece of paper, he/she must know the shape of the pencil, where to place the fingers on the pencil, how much strength to use, where to place the hand on the paper, how much force to use when writing, and which muscles to use when writing.

The autonomic nervous system (ANS) forms part of the peripheral nervous system. It consists of two major systems, the sympathetic nervous system and the parasympathetic nervous system (Figure 2.7). The parasympathetic system plays a role in the daily routine aspects of bodily functioning, such as breathing, sleeping and so on. The sympathetic reacts when the body encounters a threatening situation. Its task is to protect the individual from perceived dangers, which for example, could be in the form of an unexpected sound, an attacking dog or too much stress. In such circumstances, chemicals effect a change from parasympathetic to sympathetic control, which elicits fright, usually followed by flight or fight (Kokot, 2006).

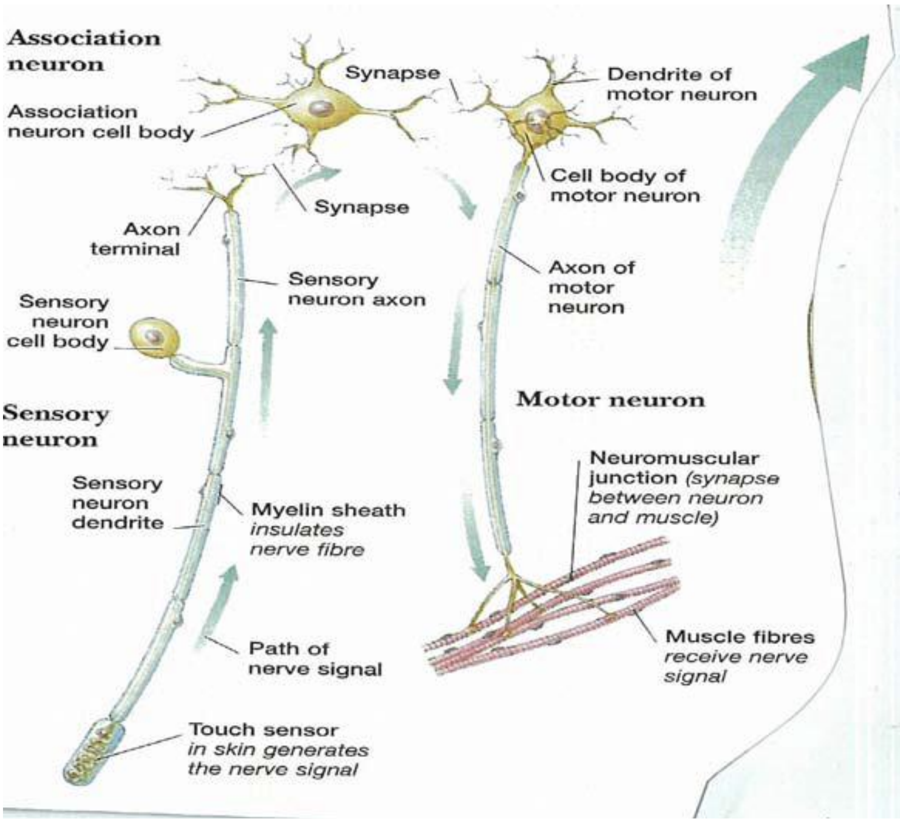

Figure 2.6: Three types of neurons (Walker, 2003:78)

The nerve structure consists of nerve cells called *neurons*. The neurons carry tiny electrical impulses, which make up a nerve message. Each neuron consists of a cell body with a nucleus and fine branches, which are called *dendrites*. The cell body has one long branch called *an axon*. Messages are received in the form of electrical impulses that are passed to the center of the neuron. The axons have the task of carrying messages to the dendrites of the next nerve cell (Parker, 2007). The main nerves of the body consist of bundles of axons, which are surrounded by *myelin sheath* (Figure 2.8). This is a fatty layer that insulates and protects the axon and helps speed up the impulses from the brain (Hall, 2005). All these components constitute the neuron system (Figure 2.9).

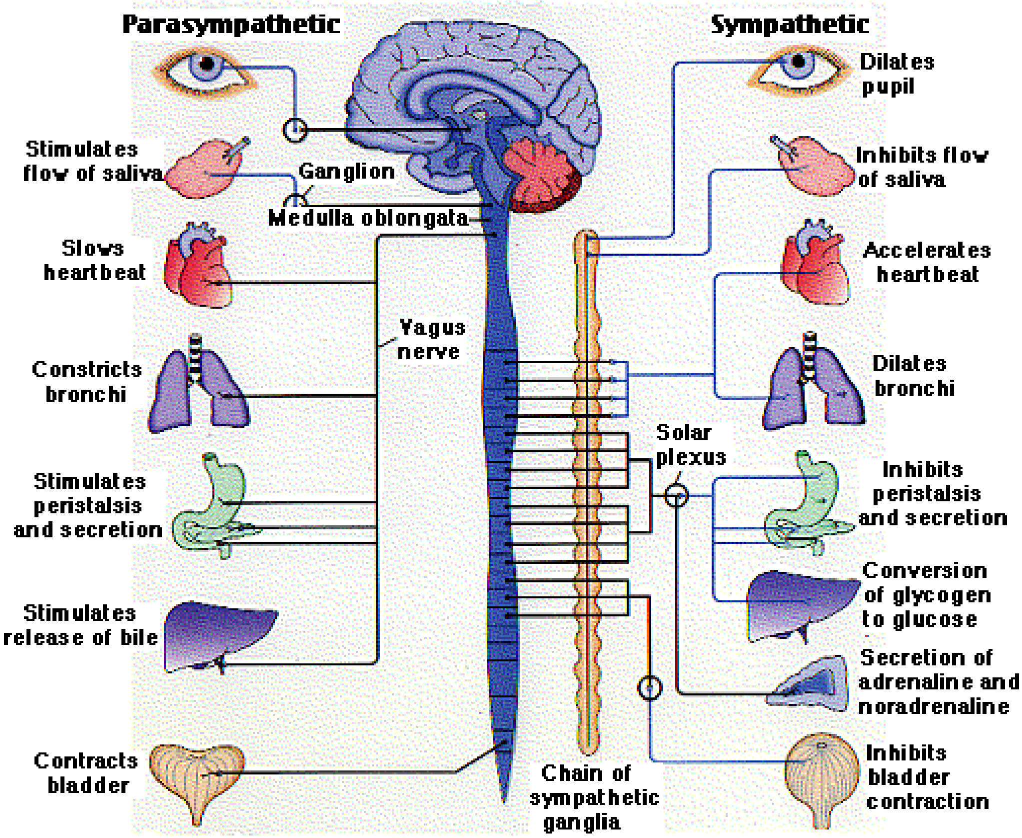

Figure 2.7: The autonomic nervous system (http://www.drstandley.com/bodysystems_centralnervous.shtml)

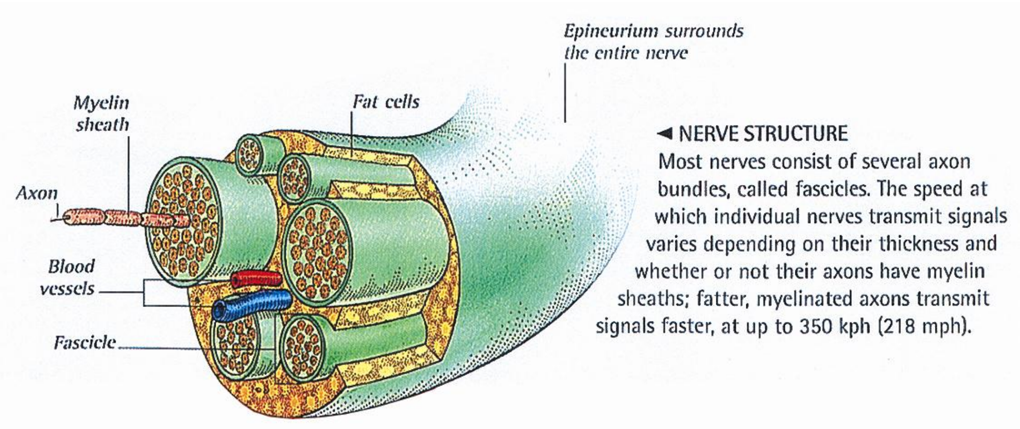

Figure 2.8: The nerve structure (Walker, 2003:83)

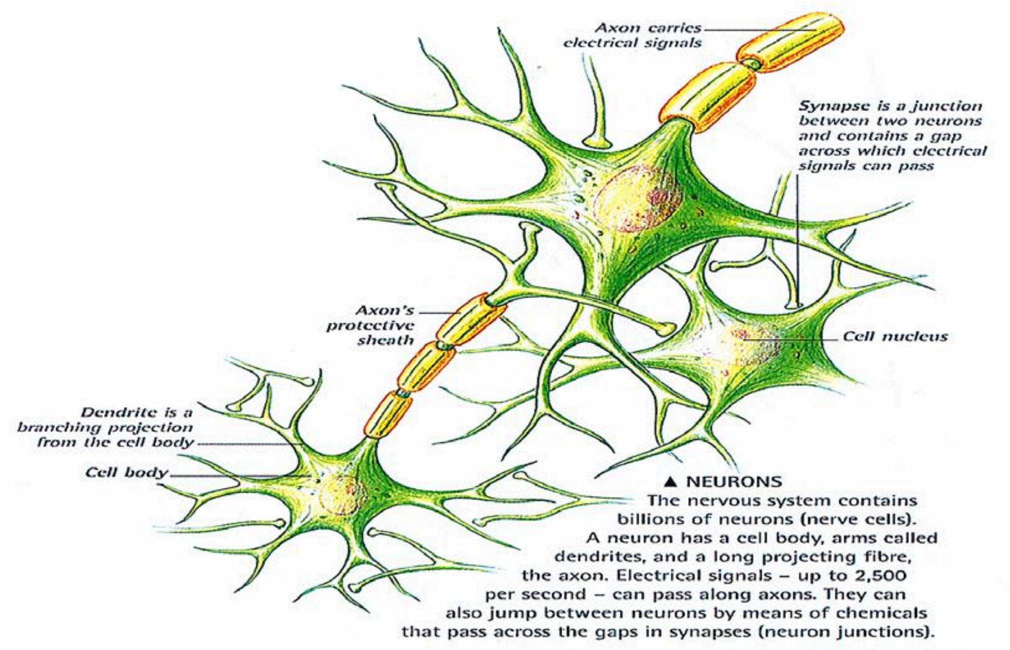

Figure 2.9: The neuron system structure (Parker, 2007:71)

2.8 ESSENTIAL LEARNING WHICH TAKES PLACE THROUGH MOVEMENT

2.8.1 Spatial knowledge (awareness)

Children need to experience orienting their bodies in space by going up, on, under beside, inside, and in front of things. Should they not be subjected to spatial orientation, it is possible they will have difficulty dealing with the letter identification and orientation of symbols on a page. The difference between *p, b* and *d* depends on orientation in space. All are composed of a line and a circle; it depends on which side of the circle the line is. Motor movements serve to promote sensory integration. Movement also provides the opportunity to learn left and right which is crucial to reading. A child who does not know left from right will not know where to start reading, could skip lines and stop in the middle of the sentence (Corso, 1993; Burn, 2007).

Movement in space using the whole body forms the foundation for school readiness tasks like reading, writing and mathematics. The concept of space and the position in space is not something that can be taught to a child. A child has to experience position in space through movement. As in the example already given*, p, b* and *d* are all the same shape, only their positions differ. The teacher is the mediator in providing the child with spatial experiences (Corso, 1993).

2.8.2 Knowledge about the topology

According to Calitz (1997), topology refers to the internal map of each child's surroundings. In the beginning it is constructed by the young child's knowledge of the concrete surroundings. Jensen (2000b) states that movement gives a child a new spatial reference and thus enhances spatial learning. The brain forms maps of the body's relationship to the scenery. The function of this concept is to help children with knowledge of direction and position in space, as well as help them form an important ingredient of problem solving. Knowledge of direction includes, up, down, around, under (Calitz, 1997). This knowledge is essential within the classroom setup, especially when calculation, writing and reading takes place.

2.8.3 Foreground/background concepts

It is very important for children to be able to distinguish between objects that are near, far, in the foreground and in the background. These concepts are closely related to the spatial concepts and topology. Example: when a child needs to throw a beanbag into a box, he/she needs to know how far and in which direction to throw (Calitz, 1997). In the classroom the child must be able to distinguish what is in front of him/her and what is on the board. An infant that does not experience the body in space (tummy time and crawling) will find this concept rather difficult later in life.

2.8.4 The ability to focus on a specific point

According to Hannaford (2005, 2007), on entering school, children are often expected to develop their focus quickly in order to see small, static, two dimensional letters on paper. The transition from three dimensional (working with shapes in preschool) and peripheral focus is very abrupt and in many cases unnatural.

In order to catch a beanbag, write in a specific place or read a word, a child needs to focus on a specific point and keep his/her focus until the task is completed. Experiences in movement help with the development of focusing, that is, keeping an eye on the ball until it is caught. Ocular motility is therefore required. This motor skill is also required in drawing, reading and writing exercises (Kokot, 2006).

2.8.5 The ability to follow an object through space

There is no possibility for teaching children the ability to follow an object through space other than through practical experience. Examples are, for instance, to follow the beanbag with the eyes only, anticipating where the beanbag is going, positioning to catch and anticipating the force and direction the beanbag needs to reach the target. Experiences over long periods are required to develop the perceptual-motor abilities necessary for the tasks. The ability to follow an object in space is important when it comes to following a written line from left to right and back to left, as well as to continue with the following line. This action is required for reading and written work. Numerous experiences in moving, kicking and throwing will help with acquiring speed to read (Calitz, 1997). The more the eyes move, the more the muscles of both eyes need to work together. Visual stress occurs when eyes cannot focus effectively or track together. According to Hannaford (2005), this is due to a lack of integrated, whole body movement and vestibular system development.

2.8.6 Body awareness

There are numerous perceptions as to what body awareness is. Terms include body image, body concept and body schema. According to Cheatum and Hammond (2000), body image is seen as a self-concept. A positive body image will enable a child to successfully experience movement.

Problems with body image are seen in drawings from children who do not draw various body parts, as they lack the necessary skills to do so. Movement promotes a sense of self (who I am and what can I do). Hannaford (2005, 2007) states that proprioception contributes to the development of a physical sense of self or body image – the internal awareness of the body parts.

Body concept is seen as the child's knowledge of his/her own body parts. By seven years of age, children should be able to name the minor body parts such as wrist, ankle and shins (Cheatum & Hammond, 2000). They also point out that body schema is an internal awareness of where the body parts are in relation to each other. Muscles, joints, skin and soft tissue feed the messages to the brain. A lack of body schema is seen when children are unable to coordinate their movements. Positive movement experiences where a goal is reached or emotionally important adults are pleased, forms a positive self-concept in the child. Hand dominance as well as reading is based on a sound body image.

2.8.7 Problem solving

Movement assists with the skills of problem solving that are acquired at the basic, concrete level in the early years. Exploration of the environment and creative problem solving forms an important part of the cognitive thinking process. Young children solve problems by trial and error (Calitz, 1997). Climbing trees, building puzzles and packing blocks are some of the activities, which help acquire and develop the necessary problem solving skills required for learning.

2.9 THE REQUIREMENTS FOR LEARNING

When children communicate they require skills related to both motor and mental activity; the motor activity of speech or gesture, and the mental activity that formulates what is to be said. In the course of learning these skills, an individual's performance can be improved considerably through practice so that the skills can eventually be performed without conscious attention to detail. Sitting at a desk requires a well-developed balance system (vestibular). This system starts developing in utero and requires movement to enhance its functioning. Speech is dependent on the motor system for the control of the lips and tongue. Writing is a motor task, which relies on the coordination of the eyes and the hand with the support of the postural system. Reading is an ocular motor skill, which is dependent on the proper functioning of the vestibular system, proprioceptive system and the visual system (Cheatum & Hammond, 2000). Therefore, the sensory systems have to be in sync to enhance quality learning. Goddard Blythe (2000) is of the opinion that one has to consider the "ABC" (Attention, Balance and Coordination) of learning in order to gain optimal learning readiness.

2.9.1 Attention

When children have to pay attention, they require the ability to focus, have a conscious awareness of a specific task – particularly when that task is being learned – and they require a high level of arousal. Attention is dependent on the ability to reject irrelevant sensory stimuli such as: background noise, movement within the visual field (someone walking past the open door) and sensations from the muscles and skin (the irritation of the chair or someone standing close to them).

According to Goddard Blythe (2000), in the early stages of development it is normal to be stimulus-bound. A child's capacity for sustained, self-directed attention starts to increase at the same time as basic perceptual-motor functions begin to mature. When given any task, a balance must be struck between sensory-motor and cognitive processing. If the demands of body management are great, then less information processing can take place at a cognitive level. Motor skills are expressed through movement, balance and posture. The child's motor abilities at key stages in development can provide insight into his/her development level of operation.

2.9.2 Balance

This refers to the control of the body. It is the most advanced level of movement in order to stay totally still. A larger support surface is required by the baby to support the whole body (think of a small baby lying on its stomach and eventually having to stand on only two small feet and still stay balanced). As balance improves, less movement and support from other body parts is required. It is necessary that the child gain mastery over the most basic developmental skills in order to move to the next level (Goddard Blythe, 2000; Leppo *et al.,* 2000).

2.9.3 Coordination

Coordination is a result of all the body parts working together in an efficient and organised way. This is an essential, functional link between learning and movement. Children (aged 5 - 6) who find it easy to control their body's movement, to sit still and focus their attention on a specific task, are showing that they are neurologically ready to begin learning. Research has shown that the body acts as a receptor for information and the medium through which knowledge is expressed. By using specific movement exercises, for reflex stimulus, various reflex abnormalities have been corrected and this has resulted in improved reading and writing activities. In order for a child to sit or stand still and pay attention, entire muscle groups must work together in co-operation with balance and postural systems (coordination). Coordination requires the brain to gain control over balance, posture and involuntary movement (Goddard Blythe, 2000; Leppo *et al.,* 2000).

Goddard Blythe (2000) states that between the ages of six and a half and eight years old, the myelination is completed which strengthens neurological connections between the vestibular system, the cerebellum (coordinator of fine motor movements) and the corpus callosum (connection between the two cerebral hemispheres). It is only once these systems are operating in sync that the child's sense of direction becomes stable. Movement can be effectively used as a tool in order to help the child develop emotionally, intellectually and physically. Incorporating movement has various benefits with regards to learning.

2.9.4 Laterality

This refers to the internal awareness of the two sides of the body, namely left and right, as well as the awareness that the two sides are different. Children start to develop this sense at the age of 4 years. By the age of seven, 70% of children should be able to identify the two sides of the body. Should children at the age of 10 not be able to identify left from right they could be at a learning disadvantage. Lateral preference refers to the use of the eyes, hands and feet on the same side of the body. Laterality serves as the foundation for directionality (Cheatum & Hammond, 2000; Kokot, 2006). Deficits in this area show up in reading when the child is unable to see that words consist of letter combination, reading is from left to right, and that he/she is required to hold a book right side up to read.

2.9.5 Midline

The midline is an imaginary line dividing the body into equal parts: two sides, top and bottom, and front and back. The midline is like a wall that keeps a child from crossing one arm or leg across the center of this body into the other half (Pheloung, 2006).

Midline crossing develops automatically after a child has developed lateral preference. It could sometimes only develop at about seven years of age (Cheatum & Hammond, 2000). If this persists, it slows down academic work when both sides of the brain should be working easily together (Pheloung, 1997).

Certain movement activities provide the opportunity for children to enhance crossing the midline. If the child has not acquired the skill, it will have a devastating effect on school performance. Children who cannot cross the midline tend to focus on the paper with a vertical orientation, sometimes writing or drawing down the longitudinal center of the page and sometimes changing the pencil to the other hand at the midpoint of the paper. Children who cannot cross midline tend to stop reading in the middle of the line (Corso, 1993).

2.9.6 Directionality

Only once a child has developed a well-defined sense of laterality and knowledge of the body, can directionality be built. The child transfers knowledge of the right and left sides of the body into space. Only once the child has learnt laterality can the three references of directionality be learnt: namely left and right, up and down, and in front and behind (Pheloung, 1997; Pheloung, 2006).

The daily tasks in school involve considerable directionality: writing in the top right hand corner of the page or folding the right side of the paper to the left side. Even getting dressed requires knowledge of directionality; knowing the front from the back, and the left sleeve from the right sleeve, and one's own left and right side.

2.9.7 Inter-hemispheric Integration

The human brain consists of two hemispheres, which function like two networked computers. The left side receives motor and sensory input from the right side of the body and the right side receives input from the left side of the body (Wang & Aamodt, 2011). Inter-hemispheric integration refers to the communication between the left and right cerebral hemispheres of the brain. It entails the coordination of the left with the right side and infers the separate functioning of each side as well (Figure 2.9).

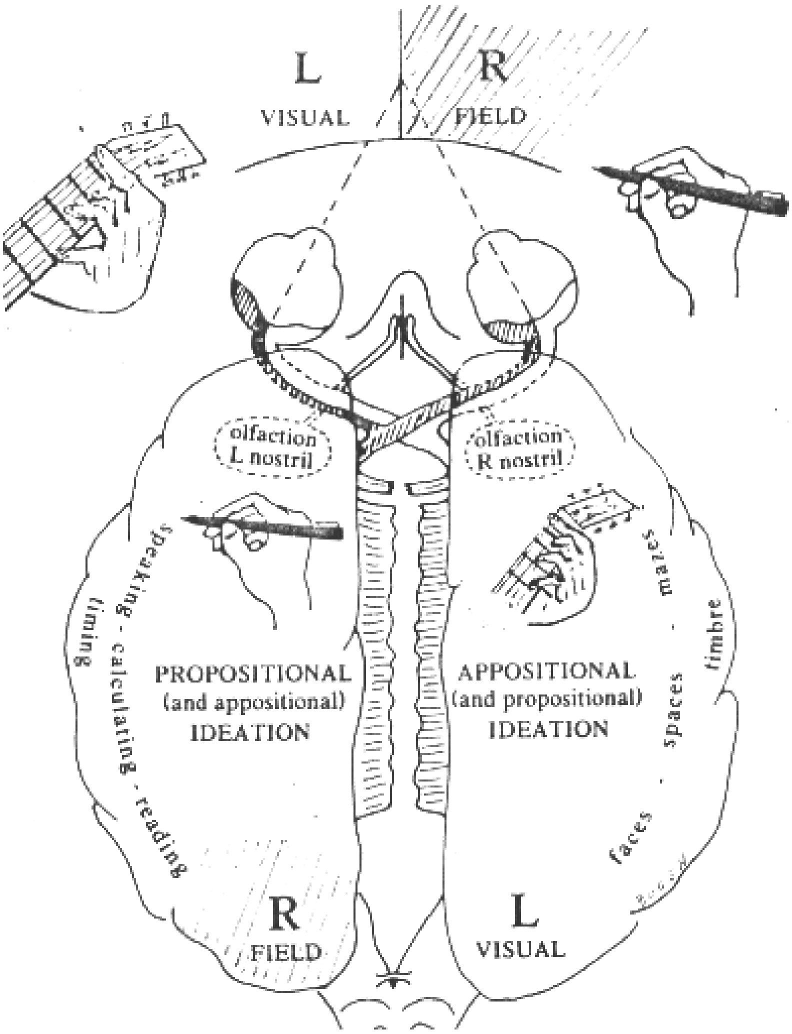

Figure 2.10: Inter-hemispheric integration (The split brain, http://www.its.caltech.edu/~jbogen/text/ref130.htm)

2.10 ACADEMIC PERFORMANCE

Academic achievement or (academic) performance is the outcome of education — the extent to which a student, teacher or institution has achieved their educational goals (http://en.wikipedia.org/wiki/Academic_achievement).

Academic performance is commonly measured by examinations or continuous assessment but there is no general agreement on how it is best tested or which aspects are most important. (Ward *et al.,* 1996; Ardoy *et al*., 2014).

In this review, academic performance is used broadly to describe different factors that may influence student success in school. These factors are grouped into three primary areas:

2.10.1 Cognitive Skills and Attitudes

Cognitive skills and attitudes include both basic cognitive abilities, such as executive functioning, attention, memory, verbal comprehension, and information processing, as well as attitudes and beliefs that influence academic performance, such as motivation, self-concept, satisfaction, and school connectedness. Studies used a range of measures to define and describe these constructs. All these constructs definitely have an effect on performance in school; one of the most influential is motivation (Grissom, 2005)**.**

Motivation, also referred to as academic engagement, refers to "…*cognitive, emotional, and behavioural indicators of student investment in and attachment to education"* (Tucker *et al.,* 2002: 477).

It is obvious that students who are not motivated to succeed will not work hard. In fact, several researchers have suggested that only motivation directly affects academic achievement; all other factors only affect achievement through their effect on motivation (Tucker *et al*., 2002). However, it is not as easy to understand what motivates students. Numerous studies have been conducted on this topic, which has led to the development of several theories of motivation. One widely accepted theory is the "Goal Theory". It postulates that there are two main types of motivation for achieving in school. Students with an ability or performance goal orientation are concerned with proving their competence by getting good grades or performing well compared to other students (Maehr & Midgley, 1991; Anderman & Midgley, 1997).

On the other hand, students with a task goal orientation are motivated by a desire to increase their knowledge on a subject or by enjoyment from learning the material. Studies have shown that students with a task goal orientation are more likely to engage in challenging tasks, seek help as needed, and adopt useful cognitive strategies. Possibly the most important fact is that they tend to be happier both with school and with themselves as learners (Ames, 1992; Anderman & Midgley, 1997).

Subsequent research has suggested, however, that despite its potential implications for middle school policy and curriculum design, a dichotomous perspective of either “task-based” or “performance-based” goals may be too simplistic of a model of adolescent motivation (Dowson & McInerney, 2001). In addition, research has also suggested that task and performance goals are not mutually exclusive. While many experimental studies forced research participants to select one goal orientation or the other, correlational research has found that individuals’ endorsement of a task goal orientation is often weakly correlated or uncorrelated with endorsement of a performance goal orientation (Kaplan & Maehr, 2002). Researchers have also identified a number of other student goals. A third academic goal orientation is work avoidance, where students try to minimize the amount of effort they put into tasks (Dowson & McInerney, 2001).

Students also have social goals that influence their motivation, alongside academic goals. Urdan and Maehr (1995) describe four types of social goals: “*social approval*”, “*social compliance*”, “*social solidarity*”, and “*social concern*”. Research involving qualitative methods has suggested that social goal orientations are associated with academic achievement (Kaplan & Maehr, 2002).

Dowson and McInerney (2001) found that many studies utilize a priori approach to identify student goals. They argue that this method is ineffective since it limits the range and descriptions of goals. They instead inductively generated a list of goals by interviewing and observing middle school children and then categorizing these results. They found that students showed characteristics of four different goal orientations: work avoidance, social affiliation, social responsibility, and social concern.

Students attempting to avoid work often had the teacher complete their work for them, copied off of another student, or simply engaged in off-task behaviours (Dowson & McInerney, 2001).

While the social affiliation orientation is usually also considered detrimental to students' work habits, students in this study said working with their peers helped engender a sense of belonging but also helped them work more effectively and promoted positive feelings toward learning. Only on occasion would working with other students lead the students off task. Students with a social responsibility goal orientation were motivated by a desire to fulfil their role expectations. These included parent, teacher, and peer expectations (such as participating in extracurricular activities, helping the class as a whole or individual students, and behaving responsibly when holding an important student government position). Students felt proud, excited, and satisfied when they met these expectations (Dowson & McInerney, 2001).

Students with a social concern orientation worked hard to succeed so that they could then help others. This orientation therefore shows that academic achievement is both a result of, and a precursor to, pro social behaviour. Overall, Dowson and McInerney (2001) concluded that perhaps researchers were incorrectly focusing on performance and task goals when students are actually most concerned with meeting their social goals at the middle school level.

Aside from goals, many other factors contribute to students' motivation. "*Self-Determination Theory*" states that students need to feel a sense of competence, a sense of relatedness to others, and a sense of autonomy (Anderman & Midgley, 1997). Competence involves not just having the knowledge to complete various tasks, but also believing that one can do so. Relatedness refers to the connections that are formed with one's peers. Autonomy includes initiating and regulating one's tasks. These student needs are particularly relevant to adolescents in middle school since children at this age are developing a sense of identity and have increased cognitive abilities (Anderman & Midgley,1997).

Ryan (2001) further investigates the importance of relatedness, specifically looking at the impact of one's peer group on motivation. Relationships with peers become much more important in early adolescence as children start to spend more time with peers and form relationships that are closer and more intense than before (Ryan, 2001). This is also the age at which children are most influenced by their peers. In the study, students' motivation and achievement was measured at the beginning and end of their first year of middle school, and a social network analysis was used to identify peer groups. The results showed that the peer groups accounted for change in students' achievement over the school year after controlling for selection. Peer groups also influenced changes in intrinsic value for school, though they did not impact views on the usefulness and importance of school.

Attribution Theory addresses students' sense of competence, specifically how students are affected by their previous performance. It suggests that students are more influenced by their perceptions of what caused their earlier successes and failures than by the actual experience (Anderman & Midgley, 1997).

While it is popularly believed that students who are successful will want to continue being successful, Weiner suggests this does not occur if students do not attribute the success to their own actions and instead attribute it to something else, such as luck (as cited in Anderman & Midgley, 1997). Furthermore, when students fail, they are more likely to be motivated to try harder the next time, only if they think that lack of studying or something else in their control led to the failure, rather than attributing the failure to things outside their locus of control.

2.10.2 Academic Behaviours

Academic behaviours include a range of behaviours that may have an impact on students' academic performance. Common indicators include on-task behaviour, organization, planning, attendance, scheduling, and impulse control. Students with poor impulse control have more difficulty motivating themselves to study, do homework and listen in class. This can decrease their ability to excel academically, even when they perform well on IQ and achievement tests. Wang and Aamodt (2011) emphasize that rule setting and teaching frustration tolerance play critical roles in helping children develop impulse control.

Individual differences in academic performance have been linked to differences in intelligence and personality (von Stumm *et al.,* 2011). Students with higher mental ability as demonstrated by IQ tests (quick learners) and those who are higher in conscientiousness (linked to effort and achievement motivation) tend to achieve highly in academic settings. A recent meta-analysis suggested that mental curiosity (as measured by typical intellectual engagement) has an important influence on academic achievement, in addition to intelligence and conscientiousness (California Department of Education, 2005)**.**

Children's semi-structured home learning environment transitions into a more structured learning environment when children start first grade. Early academic achievement enhances later academic achievement (Bossaert *et al.,* 2011).

Parent's academic socialization is a term describing the way parents influence students' academic achievement by shaping students' skills, behaviours and attitudes towards school (Magnuson, 2007). Academic socialization can be influenced by parents' socio-economic status. Highly educated parents tend to have more stimulating learning environments. Children's first few years of life are crucial to the development of language and social skills. School preparedness in these areas helps students adjust to academic expectancies (Lassiter, 1995).

2.10.3 Academic Achievement

Academic achievement includes standardized test scores in subject areas such as: reading, math, and language arts; GPAs; classroom test scores; and other formal assessments **(**California Department of Education, 2005)**.** According to the

Assessment Policy, published by the South African Basic Education Department (Department of Education, 2002), assessment is of high importance:

- Assessment is the process consisting of collecting, analysing and interpreting information in aim to help teachers, parents and other stakeholders to make determinations regarding the progress of learners. This National Curriculum Statement is formally followed by all South African Schools; and
- Classroom Assessment should be in the most efficient and appropriate manner, indicative of learner performance and should ensure that sufficient evidence of achievement is obtained through a variety of assessment forms. The purpose of the Assessment Policy is to regulate how evidence of student performance is documented and reported.

2.11 ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND COGNITIVE FUNCTIONING

Most scientists and teachers find it obvious that cognitive development and brain development are closely related, and the enterprise of connecting mind, brain, and education starts with that assumption. Many brain characteristics, number of neurons and synapses, brain mass, myelination, brain activity and so forth, change systematically as children grow up. Children's actions, speech, concepts, problem solving, social skills, motivation and emotion all develop simultaneously. All these various changes are globally correlated, but the correlations are not very informative because everything is changing in parallel (Miller, 1994).

Research on brain development indicates that cognitive development occurs in tandem with motor ability (Smith *et al.,* 1999). Several review articles also have examined the connections between physical activity and academic behaviour and achievement. Sibley and Etnier (2003) conducted a meta-analysis of published studies relating physical activity and cognition in youth. Two additional reviews described the evidence for relationships between physical activity, brain physiology, cognition, emotion, and academic achievement among children, drawing from studies of humans and other animals across their lifespan (Tomporowski *et al.,* 2008).

Studies have shown that physical activity can increase neural activity in the brain. Exercise specifically increases executive brain functions such as attention span and working memory (Tomporowski *et al.,* 2008). According to Jensen (2000a), proper brain function is dependent on early motor development. The ages two to six years old appears to be particularly critical to a child's motor development as it is during this period that muscle strength, coordination, balance, and spatial skills are developed, which have a tremendous impact on cognition (Ardoy *et al.,* 2014).

Delacato (1966) points out that incomplete neurological organization can have potentially detrimental effects on reading ability. Preventive or corrective measures include mastering general motor patterns, such as homolateral crawling at the lowest stage and creeping, and walking naturally and walking in cross patterns at later stages. Recent research conducted by Goddard Blythe (2006) has provided growing evidence, which supports the long held theory, that control of balance; motor skills and the integration of early reflexes are linked to academic achievement. Many children underachieve as a result of immature motor skills.

Olds (1994) considers movement and action as essential to children's development in general and to intellectual development in particular. Movement is seen as the gateway to sensing, acting upon and being affected by the world around us. She further states that, according to Piaget, movement is essential to the formation of intellect. Piaget refers to the first stage of intellectual development as the sensory motor stage. This is when children experience the world primarily through their senses and motoric abilities. According to Olds (1994), Piaget argued that the sensory motor stage is the basis on which the subsequent hierarchy of all intelligence is built. Between birth and five or six years, children's bodies, as well as their minds, are the organs of intelligence. De Jager (2009) agrees with the previous statements and adds that babies 'talk' through movement. During the sensory-motor process the far senses (touch, smell, taste, sight, and hearing) and the near senses (vestibular, proprioceptive and kinaesthetic systems) are developed through movement.

Radler and Kephart (1960) emphasized the importance of visual development and intellectual development, which in turn is dependent on simple motor skills. Poor motor coordination results in decelerated intellectual growth. According to them, coordination is composed of (1) laterality – the sense of one's symmetry, of leftness and rightness and (2) directionality – laterality projected into space, which is obtained through and experienced in motor skills. An inability to perform or realize laterality and directionality must be overcome if the child is to be successful in school.

Goddard Blythe (2000) campaigns that attention (A), balance (B) and coordination (C) constitute the primary ABC upon which all later learning depends. If the afore mentioned aspects are not developed by the time children enter school, they run the risk of developing specific learning difficulties. This is not because these children lack intelligence, but is purely because the basic systems that are fundamental to learning are not fully in place by the time they start school.

Research has also explored the relationships among physical education and physical activity, fitness levels and motor skill development, and academic performance. For example, several studies have shown a positive relationship between increased physical fitness levels and academic achievement as well as fitness levels and measures of cognitive skills and attitudes (Castelli *et al.,* 2007). In addition, other studies have shown that improved motor skill levels are positively related to improvements in academic achievement (Knight & Rizzuto, 1993; Nourbakhsh, 2006; Son & Meisels, 2006) and measures of cognitive skills and attitudes (Boykin & Allen, 1988; Oja & Jürimäe, 2002; Reynolds & Nicolson, 2007).

During the various trials conducted by the Institute for Neuro-Physiological Psychology (Chester in UK), a simple movement programme was implemented in various schools. As a result of this programme, children showed improved coordination, visual-motor and auditory skills, as well as improvement in reading and comprehension (Krog, 2010).

Pheloung from Australia designed another well-known movement programme, which cannot be ignored, named "Move to Learn". This movement programme was designed to help the immature child develop to full potential and is still being offered at various places worldwide (Pheloung, 1997). The reason for choosing movement as the basis of the programme was that movement is considered the basis for growth and development. It is evident from this programme that the child's ability to organise the body enables him/her to organise him/herself at home (by getting dressed) and in the classroom (by getting school books in order). Movement is thus seen as the basis to help the brain integrate in preparation for academic work.

Pheloung (2003) identifies the lack or insufficient degree of movement during a child's development stages as the main contributor to most learning restraints. She mentions only a few: midline crossing problems, inability to do cross pattern walking, balance problems, inadequate messages to the brain from the joints and muscles, and inadequate messages from the skin to the brain and immature body awareness. This results in a lack of learning readiness. Goddard Blythe (2002) adds to this argument by stating that the underlying factors overlap with the symptoms of the diagnostic categories of dyslexia, dyspraxia, attention deficit disorder and dysfunction of attention.

Preliminary results from a series of studies (Ismail & Gruber, 1971; Dwyer *et al*. 2001) undertaken with elementary school children do indicate a strong relationship between academic achievement and fitness scores. One study found that physically fit children identified visual stimuli faster. Brain activation patterns provided evidence that the fit children allocated more cognitive resources towards the task, as well as processing information faster (Battro & Fischer, 2006).

John Bruer, executive administrator of the James S. McDonnell Foundation, began a series of articles that were critical of brain-based education (Bruer; 1999). To verify the hypothesis of these articles, the researchers have verified the applied research to find out what happens to learners' achievement in schools when physical activity is either added or increased.

The research in this arena is diverse because there are no broadly established protocols. For example, there are questions about when and how much physical activity is needed, what kind, and whether it should be voluntary. These are not trivial issues; our brains respond better to meaningful activities with appropriate duration and intensity over enough time to make changes. Voluntary activity is important too. If the activity is forced, it is likely to generate distress, cause learners to become dyscognitive or affects health benefits. But when the studies are well designed, there is support for physical activity in schools. So the interdisciplinary promotion of physical activity as a "*brain-compatible*" activity is well founded (Bruer, 1999).

Because of the importance attached to motor generalizations in intellectual development, natural questions arise. Are professional athletes more intelligible individuals? Athletes have the potential for high intellectual attainment, but only if they have successfully gone through all the development levels during childhood.

2.12 PHYSICAL ACTIVITY AND HEALTH

Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. Frequent physical exercise boosts the immune system and helps prevent the "*diseases of affluence*" such as heart disease, cardiovascular disease, Type 2 diabetes and obesity (Stampler *et al.,* 2000; Hu *et al.,* 2001; Bryan *et al*., 2014). It also improves mental health, helps prevent depression, helps to promote or maintain positive self-esteem, and can even augment an individual's sex appeal or body image, which is also found to be linked with higher levels of self-esteem (medical-dictionary.thefreedictionary.com).

Physical exercise is important for maintaining physical fitness and can contribute positively to maintaining a healthy weight. Childhood obesity is a growing global concern and physical exercise may help decrease some of the effects of childhood and adult obesity. Health care providers often call exercise the "*miracle"* or "*wonder*" drug — alluding to the wide variety of proven benefits that it provides. Exercise reduces levels of cortisol (Cornil *et al.,* 1965), which causes many health problems, both physical and mental (Cohen *et al.,* 1991).

2.12.1 Cardiovascular system

The beneficial effect of exercise on the cardiovascular system is well documented. There is a direct relation between physical inactivity and cardiovascular mortality. Physical inactivity is an independent risk factor for the development of coronary artery disease. The greatest potential for reduced mortality is for the sedentary to become moderately active. Most beneficial effects of physical activity on cardiovascular disease mortality can be attained through moderate-intensity activity (AHA: Physical activity recommendations).

2.12.2 Immune system

Although there have been hundreds of studies on exercise and the immune system, there is little direct evidence on its connection to illness. Epidemiological evidence suggests that moderate exercise has a beneficial effect on the human immune system; an effect which is modelled in a *J* curve. Moderate exercise has been associated with a 29% decrease in incidences of upper respiratory tract infections (URTI) (Nieman, 1994).

Biomarkers of inflammation such as C-reactive protein, which are associated with chronic diseases, are reduced in active individuals, in relation to sedentary individuals. The positive effects of exercise may be due to its anti-inflammatory effects. In individuals with heart disease, exercise interventions lower blood levels of fibrinogen and C-reactive protein – an important cardiovascular risk marker (Swardfager, 2012). The depression in the immune system following acute bouts of exercise may be one of the mechanisms for this anti-inflammatory effect (Gleeson, 2007).

2.12.3 Brain function

Physical activity has been shown to be neuroprotective in many neurodegenerative and neuromuscular diseases (Grondard *et al.,* 2005).

Exercise affects the brain on multiple fronts. It increases heart rate, which pumps more oxygen to the brain. It also aids the bodily release of a plethora of hormones, all of which participate in aiding and providing a nourishing environment for the growth of brain cells. Exercise stimulates the brain plasticity by stimulating growth of new connections between cells in a wide array of important cortical areas of the brain. Recent research demonstrated that exercise increased growth factors in the brain – making it easier for the brain to grow new neuronal connections (Molteni *et al.,* 2004). Furthermore, exercise increases chemicals in the brain that help cognition, such as dopamine, glutamate, norepinephrine, and serotonin (Parker-Pope, 2001).

An age-related study (Luskin & Goldman, 2001) reported at the 2001 Society for Neuroscience Conference that, following a 12 week regimen of jogging for 30 minutes two to three times a week, young adults significantly improved their performance on a number of cognitive tests. The scores fell again if participants stopped their running routine. In this particular case, it does not seem that the level of fitness is the primary cause; otherwise, one would expect test performance not to be so quickly affected by the cessation of physical activity. The researchers suggested that increased oxygen flow to the brain might have been the reason for the improvement in mental sharpness. Oxygen intake did rise with the joggers' test scores. Supplemental oxygen administration has been found to significantly improve memory formation in healthy young adults, as well as improving reaction time (Luskin & Goldman, 2001). Another study showed that the antidepressant effect of running was also associated with more cell growth in the hippocampus, an area of the brain responsible for learning and memory (Bjørnebekk *et al.,* 2005).

2.12.4 Depression

From a behavioural perspective, the same "*antidepressant-like*" effects associated with *"runner's high*" found in humans are associated with a drop in stress hormones. Endorphins act as a natural pain reliever and antidepressant in the body (Thase, 2007).

The levels of both circulating serotonin and endorphins are increased when a person exercises (Byrd, 2010). These levels are known to stay elevated even several days after exercise is discontinued, possibly contributing to improvement in mood, increased self-esteem, and weight management (Fox, 1999). Exercise alone is a potential prevention method and/or treatment for mild forms of depression (Public Health Nutrition, 1999).

2.12.5 Myokine research

Developing research has demonstrated that many of the benefits of exercise are mediated through the role of skeletal muscle as an endocrine organ. That is, contracting muscles release multiple substances known as myokines, which promote the growth of new tissue, tissue repair, and multiple anti-inflammatory functions, which in turn reduce the risk of developing various inflammatory diseases (Pedersen, 2013).

In a 2012 article regarding myokine research, Pedersen and Febbraio (2012:457-65) concluded that "…*physical inactivity and muscle disuse lead to loss of muscle mass and accumulation of visceral adipose tissue and consequently to the activation of a network of inflammatory pathways, which promote development of insulin resistance, atherosclerosis, neurodegeneration and tumour growth and, thereby, promote the development of a cluster of chronic diseases. By contrast, the finding that muscles produce and release myokines provides a molecular basis for understanding how physical activity could protect against premature mortality*."

Physical inactivity or muscle disuse potentially leads to an altered or impaired myokine response and/or resistance to the effects of myokines, which explains why lack of physical activity increases the risk of a whole network of diseases, including cardiovascular diseases, T2DM (Type 2 Diabetes Mellitus), cancer and osteoporosis (Pedersen & Febbraio, 2012).

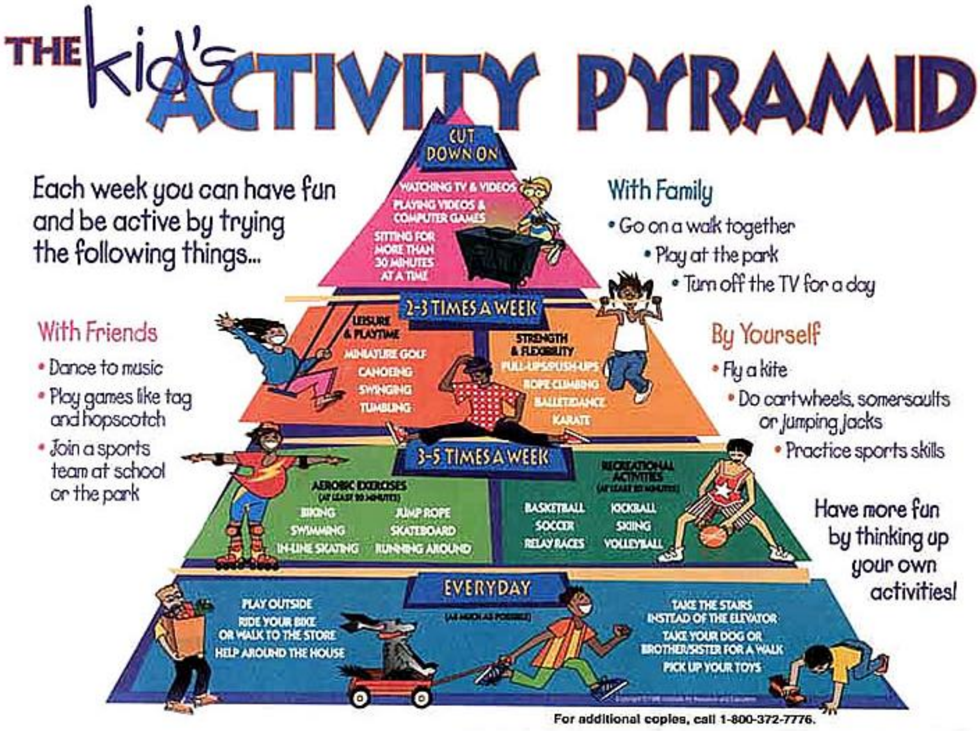

Figure 2.11: The kids Activity Pyramid.

(http://ilenequander.com/exercise-and-play-set-good-habits-for-our-kids.html/activity-pyramid-2**)**

2.13 THE MODERN LIFESTYLE

Modern society places a tremendous strain on the development of children's movement. The housing conditions, influx of people to urban areas, lack of public playgrounds and the long hours spent indoors are impeding the child's experiences in motor development. Children spend hours watching television and playing PlayStation and computer games, which encourages a sedentary lifestyle. This leads to a number of academic related issues such as inability to read, visual problems, motor problems, complications in written work as well as general lack of muscle tone. Children are transported to school and no longer walk or ride bicycles (Nel, 2002; Werner *et al.,* 1996).

Hannaford (2005) confirms that spending hours in front of the television leads to a developmental lack of imagination and reduces full sensory, motor, emotional and human interaction. Children's ability to process is exhausted by an over stimulation in their attempts to follow what is happening on the screen. The effect is that the eyes go into ocular lock (staring) and dissociative hearing (no connections between word and pictures). Furthermore, the body goes into a stress mode that inhibits all learning and memory. It also leaves the child irritable and fearful. Another impact is that children are exposed to a learning scenario that lacks physical, emotional and sensory learning, which will affect lifelong learning accordingly (Bryan *et al*., 2014).

Parents also place restrictions on their child's movements: "*Be careful not to bump this* ….."; "*Lift your hands like this*…."*Watch out for*…" This puts further restraints on their activities. Olds (1994) comments that in childcare settings, children are relegated to a playground or a single climbing structure. This is a sure way of halting the development of motor abilities. Children must be allowed to move and express themselves in a variety of ways. Failure to meet the varied needs for movement prevents children from having experiences, which are fundamental to their intellectual, social and physical development. Gagen and Getchell (2006) echo this by stating that teachers need to concentrate on designing developmentally appropriate activities, which encourage motor development.

The modern child is almost resigned to biological deterioration and physical decadence due to their inactivity and idleness (Nel in Kokot, 2006). Research conducted by Nel showed that ninety eight percent (98%) of all students choose a passive rather than an active lifestyle; the average child spends 23 hours per week in front of a television set, and only ten percent (10%) of students took part in competitive sport. Today, children are further seen as a product of a television generation that has forgotten how to play, climb trees or perform manual task around the house. The security factors in South Africa have further restricted the child's desire to play in parks and ride bicycles. Homes are tiny compartments, gardens are far too small and both parents are required to work longer hours which prohibits them from spending time with their children; children are left in day care centers for virtually the entire day. Probably the biggest constraint worldwide is untrained staff whom are not qualified to run movement programmes (Kokot, 2006; Gagen & Getchell, 2006).

During the convention of the American Association of Health, Physical Education and Recreation, Radler and Kephart (1960) offered the proposition that systematic motor explanation is the basis of all learning, since motor activity is information gathering. He stated that 15-20% of all children suffer from learning disorders – they have difficulty in learning. Children need generalized motor experiences – they need to explore, in order to have the background necessary for later success in schoolwork. These motor generalizations include:

1. Balance and posture: The child must know where gravity is as well as comprehend direction;
2. Propulsion and receipt: He should be able to move himself and objects away and toward something;
3. Locomotion: This refers to body movement through space, overcoming obstacles and changing pace. Locomotive generalizations go on unconsciously so that child may explore; and
4. Contact and manipulation: The child's relationship with objects is determined by such abilities as reaching, grasping and releasing (Radler and Kephart, 1960).

From the previous discussions, it is clear that the child has an insatiable desire for movement. Most have observed the desperate striving of a toddler to take the first step, breathless active young children running on the playground and the constant squirming of learners confined to their desks. Yet it is the educator and parent who suppress the urge to move. Parents continuously ask their children to sit still, stop fidgeting, and to pay attention. According to Hynes-Dusel (2002), it is the education system itself that considers learning to take place only when learners are sitting still and facing the teacher. I want to point out that many children find it virtually impossible to sit still and are very soon labeled as being "hyperactive", when in fact they are in need of movement to keep their systems functioning.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

In this chapter the research methodology used in the study is described. The geographical area where the study was conducted, the study design and the population and sample are described. The instrument used to collect the data, including methods implemented to maintain validity and reliability of the instrument are described.

Research involves a systematic process of collecting and logically analyzing information (data) for some purpose. There are various methods and approaches of investigating a problem or a research question. Research is also not limited to one approach (McMillan & Schumacher, 2001). Welman and Kruger (2004) acknowledge that research involves the application of various methods and techniques in order for the researcher to create scientifically obtained knowledge by using objective methods and procedures.

3.2 AIM AND HYPOTHESIS

According to Gray (2004) a hypothesis is a conjectural statement of the relation between two or more variables. Salkind (2003:7), states that a hypothesis is "…an educated guess". It is a result of questions being transformed into statements that express the relationships between variables, as an "if/then" statement.

Aim: To determine whether participation in specific motor learning activities has any effect on academic learning areas.

H_0: Whether participation in specific motor learning activities for a period of time will result in a significant difference / improvement in academic learning areas. (Directional / Statistical)

H_1: Whether participation in specific motor learning activities for a period of time will not result in a significant difference / improvement in academic learning areas. (Non-directional/Null-hypotheses)

3.3 RESEARCH APPROACH AND DESIGN

A literature investigation was used as the first step in gathering information to constitute the theoretical framework for the research. Information was obtained from scholarly articles, books, research reports, educational indexes, newspaper articles, internet websites and other relevant literature. Primary as well as secondary resources were utilized.

A combination of qualitative and quantitative research methods will be utilized in this study. When qualitative and quantitative methods of data collection are mixed, the process is term triangulation (De Vos & Fouche, 1998). Cresswell (1994) presents three models to design a study that combines the qualitative and quantitative paradigms in a single project. The three models are the two-phase model, the dominant-less-dominant model and the mixed methodology design model. For the purpose of this study the researcher will use the two-phase model.

Cresswell (1994) describes the two-phase model as that in which the researcher proposes to conduct a qualitative phase of the study and a separate quantitative phase. The advantage of this approach is that the two paradigms are clearly separate; it also enables a researcher to thoroughly present the paradigm assumptions behind each phase.

The first phase in this study consists of completing the need assessment with the teachers. During this phase the qualitative approach will be the most effective in gaining the most as well as the richest data. During the second phase of the research, the quantitative approach will be used to measure the impact of the training program on the participants.

3.3.1 Type of research

The type of research that the researcher will conduct will be applied research. Applied research addresses the current problem that the professional person experiences in practice (Arkava & Lane, 1983). De Vos and Fouche (1998:20) define applied research as research "…geared to the development of knowledge and technology with a view to achieving meaningful intervention."

For this study intervention research in the context of applied research is the most appropriate type of research. According to Schilling (1997), social work interventions include strategies that draw on and seek to strengthen the social ties between the individual and the social environment. Intervention is an action undertaken by a social worker to enhance or maintain the functioning and wellbeing of an individual, family, group, community or population. De Vos and Fouche (1998) outline three specific types of intervention research. All three types of intervention research aim to further the knowledge of an already identified field of research and improve intervention as a result. According to De Vos and Fouche (1998:69) "…as applied research, all three are directed towards shedding light on or providing possible solution to practical problems*"*. These are:

- Empirical research, to extend knowledge of human behaviour relating to human service intervention – referred to as intervention **knowledge development**, or KD;
- The means by which the findings from intervention KD research may be linked to, and utilized in, practical application – referred to as intervention **knowledge utilization**, or KU; and
- Research directed towards developing innovative interventions – referred to as intervention **design and development**, or D&D.

For the purpose of this study, the D&D model of intervention research will be followed in order to develop a training program by the sports educator/researcher for the grade 2 learner, implement the program (intervention), and evaluate the effectiveness of the program.

The intervention research model of Rothman and Thomas (D&D model, 1994) is a phase model consisting of six phases. For the purpose of this study, the researcher will focus only on the first five phases of the intervention process. The first five phases include: problem analysis and project planning; information gathering and synthesis; design; early development and evaluation; and advanced development. Dissemination, the sixth phase, is not in the intention of this study. The research procedures will be discussed during the process of intervention research.

3.4 RELIABILITY AND VALIDITY

3.4.1 Reliability

Polit and Hungler (1993) refer to reliability as the degree of consistency with which an instrument measures the attribute it is designed to measure.

Reliability can also be ensured by minimizing sources of measurement error like data collector bias. Data collector bias was minimized by the researcher being the only one to administer the motor learning program and standardizing conditions; such as exhibiting similar personal attributes to all respondents, e.g. friendliness and support.

The physical and psychological environment where data was collected was made comfortable by ensuring privacy, confidentiality and general physical comfort.

3.4.2 Validity

The validity of an instrument is the degree to which an instrument measures what it is intended to measure (Polit & Hungler, 1993). Content validity refers to the extent to which an instrument represents the factors under study.

To achieve content validity, the motor learning program included a variety of motor learning activities, which were thoroughly explained and demonstrated by the researcher. The program started in the 2nd term of the academic year and continued until the end of the 3rd term in the same academic year. Thereafter, a determination of improved academic learning results (overall achievement) has taken place by comparing the 1st term academic evaluation report to that of the 3rd term. Each participant was academically evaluated during the first and third term, by a specific qualified teacher during the course of the research.

External validity was ensured. Burns and Grove (1993) refer to external validity as the extent to which study findings can be generalised beyond the sample used. All the learners approached to participate in the study were willing; no single person who was approached refused to participate. Generalising the findings to all members of the population is therefore justified.

Seeking subjects who are willing to participate in a study can be difficult, particularly if the study requires extensive amounts of time or other types of investment by subjects. If the number of the learners approached to participate in a study diminishes, generalizing the findings to all members of a population is not easy to justify. The study needs to be planned to limit the investment demands on subjects in order to increase participation.

The number of persons who were approached and refused to participate in the study should be reported so that threats to external validity can be judged. As the percentage of those who decline to participate increases, external validity decreases (Burns & Grove 1993).

3.5 RESEARCH SETTING

The study was conducted at St. Paulus Pre- and Primary School. It is located in Brummeria, Pretoria in the Gauteng Province of South Africa. St. Paulus is a co-educational Catholic Pre-Primary and Primary School that belongs to the Independent Schools Association of Southern Africa (ISASA).

The school has 630 registered learners. The average number of learners in a classroom is 25. While St. Paulus strives to maintain the highest academic standards, they shall at all times endeavor to be sensitive to the needs of each child, affording the opportunity to realize individual potential and thereby also serve the community.

3.6 STUDY POPULATION AND SAMPLE

According to Burns and Grove (1993), a population is defined as all elements (individuals, objects and events) that meet the sample criteria for inclusion in a study. The population consisted of Gr. 2 learners enrolled in St.Paulus Pre- and Primary school.

A convenient sample of 84 subjects was selected from the grade 2 group. Mouton (1996) defines a sample as elements selected with the intention of finding out something about the total population from which they are taken. A convenient sample consists of subjects included in the study because they happen to be in the right place at the right time (Polit & Hungler 1993). The sample included forty-two randomly selected grade 2 learners, both male and female, who represented the experimental group; and the same number of learners of the same age, also randomly selected, who represented the control group.

3.6.1 Sampling criteria

Inclusion criteria:

Physically and mentally able Grade 2 learners (male and female) of St. Paulus Pre – Primary and Primary School.

Exclusion criteria:

The research study will exclude the testing of physically disabled learners, mentally impaired learners, and learners with medical conditions.

3.7 DATA COLLECTION

3.7.1 Data collection instrument

A randomly selected group of eighty-four (84) learners have taken part in the study. The experimental group (n=42) have performed a variation of specific motor learning activities. The experimental group have participated in a sixteen (16) week training program, consisting of specific motor learning activities, while the control group have only performed their regular daily activities.

Summary of activities (Full description: Appendix A) – The structured motor learning activities were designed to build the participants physical motor development. The program aimed to change the capability of responding, by practising the motor skills during the duration of this research. The following motor learning activities were included in the program as it can be defined as a sound foundation of fundamental movement and sport skills. Crawling, running, jumping, hopping, skipping, throwing, catching, kicking, stretching, and balancing.

The program provided the participant with structured motor learning activities using space and equipment. The activities were easy to implement and focused on building basic gross motor skills, important for child development.

Each activity suggests the name of the activity, its purpose, prerequisites, the suggested grade level and materials needed. Each activity includes a detailed description, which includes the variations, assessment ideas and teaching suggestions.

The number of activities have been presented and supervised by the researcher, beginning in the 2nd term of the academic year and continuing until the end of the 3rd term in the same academic year. Thereafter, a determination of improved academic learning results has taken place by comparing the 1st term academic evaluation report to that of the 3rd term.

The academic evaluation reports of the experimental group will also be compared to the control group (n=42) which has not participated in the specific motor learning program, in order to eliminate possible bias caused by the academic learning effect and adaptation throughout the course of the year.

3.7.2 Data collection procedure

The procedure followed in order to prepare, conduct tests, provide intervention and final collection of data included the following: (1) Initial contact with the school principal and permission; (2) Permission letters to parents and participants; (3)

Occupational evaluation conducted at school in an individual setting; (4) 16 week movement program; and (5) academic evaluation report.

To support this research, an occupational evaluation has been done on the experimental group to determine if any participant has an existing problem related to cognitive ability associated with academic performances. The Beery Visual-Motor Integration (VMI) measures the extent to which individuals can integrate their visual and motor abilities. It is commonly used to identify children who are having significant difficulty with visual-motor integration and to determine the most appropriate course of action. The Beery VMI is suitable for respondents with diverse environmental, educational, and linguistic backgrounds. Additionally, the test can be used as an outcome measure to assess the effectiveness of education and intervention programs (Beery, & Beery, 2010).

The occupational therapist administered the test by asking the respondent to copy geometric drawings onto a form. The drawings are presented in order of increasing difficulty. Distinct visual perception and motor coordination subtests are included, making it possible to test one skill set to the exclusion of the other. Scoring is completed on the form, according to the scale below (Table 3.1):

Table 3.1: The Beery Visual-Motor Integration (VMI)

STANDARD SCORE	PERFORMANCE	% OF AGE GROUP
>129	Very High	2
120-129	High	7
110-119	Above Average	16
90-109	Average	50
80-89	Below Average	16
70-79	Low	7
<70	Very Low	2

(Beery & Beery, 2010)

Children who perform well on VMI testing may still have visual perception or motor coordination deficits. Visual conceptualization and motor coordination should be evaluated separately to confirm the results. Children who do not perform well on VMI testing may have impairment of visual-motor skills including the following types:

- visual analysis and visual spatial ability;
- motor coordination;
- visual conceptualization; and
- visual motor integration

(www.pearsonassessments.com/tests/vmi.htm)

Together with above-mentioned evaluation, the participants were academically graded by their specific grade teacher.

Academic evaluation report of St. Paulus Pre- and Primary School (Table 3.2):

Table 3.2: FOUNDATION PHASE LEARNING AREA REPORT / GRONDSLAGFASE LEERAREA RAPPORT

GRADE TWO / GRAAD TWEE

LEARNER / LEERDER:

CYCLE / SIKLUS	**1**	**2**	**3**
Literacy English First Language			
Listening			
Speaking			
Reading			
Writing			
THRASS: Phonics			
Thinking and Reasoning			
Language Structures and Use			
Comment:			

Geletterdheid Afrikaans Eerste Taal			
Luister			
Praat			
Lees			
Skriftelik			
Spelling			
Dink en Redeneer			
Taalstruktuur en Gebruik			
Comment:			

Numeracy			
Numbers, Operations and Relationships			
Patterns, Functions and Algebra			
Space and Shape			
Measurement			
Data-Handling			
Comment:			
Life Skills / Lewensvaardighede			
Religious Education / Godsdiensonderrig			
Handwriting / Handskrif			
Health Promotion / Gesondheidsbemarking			
Personal Development / Persoonlike Ontwikkeling			
Social Development / Sosiale Ontwikkeling			
Physical Education / Liggaamsopvoeding			
Water Activities / Wateraktiwiteite			
Ball Skills / Balvaardighede			
Computers			
Computer Literacy			
Arts and Culture / Kuns en Kultuur			
Art / Kuns			
Music / Musiek			
Sepedi			
Design Technology / Ontwerp Tegnologie			
Understanding the concept of Design Technology / Verstaan Tegnologiese konsep van Ontwerp			

General / Algemeen			
Independence / Selfstandigheid			
Responsibility / Verantwoordelikheid			
Concentration / Konsentrasie			
Task Completion / Taak Voltooiïng			
Following Instructions / Verwerking van Instruksies			
Organisation Skills / Organisasievermoë			
Group work / Werk in groepsverband			
Behaviour / Gedrag			
Educator's Comment / Opmerking van Leerkrag: **Signature / Handtekening:** ______________________________			
Principal's Comment / Opmerking van Hoof: **Signature / Handtekening:** ______________________________			

Each learning area was evaluated on a 1 – 4 academic rating scale:

1 – Very Poor

2 – Satisfactory

3 – Achieved

4 – Very Good

A comparison between the research group's and control group's academic evaluation reports has been conducted before and after administration of the specific motor learning program. The correlations coefficient has been recorded to reflect the effectiveness of the motor learning program.

3.8 DATA ANALYSIS

A randomly selected group of eighty-three (83) learners has taken part in the study. The experimental group (n-42) has performed a variation of specific motor learning activities (Appendix A). The participants of the experimental group participated twice a week for 30 minutes in the motor learning program. The number of activities have been presented and supervised by the researcher, beginning in the 2nd term (April-June) of the academic year and continuing until the end of the 3rd term (July-September) in the same academic year. Thereafter, a determination of improved academic learning results has taken place by comparing the 1st term academic evaluation report to that of the 3rd term.

The academic evaluation reports of the experimental group have also been compared to the control group (n=41), which has not participated in the specific motor learning program, in order to eliminate possible bias caused due to the academic learning effect and adaptation throughout the course of the year.

The following academic learning areas have been used:

- Afrikaans ”Lees” (reading);
- Afrikaans “Skriftelik” (writing);
- Afrikaans “Dink en Redeneer” (thinking and reasoning);
- English Write ;
- English Read;
- English Thinking and Reasoning;
- Numeracy – Numbers, Operations and Relationships;
- Numeracy – Patterns, Functions and Algebra;
- Numeracy – Data Handling;
- General Concentration;
- General Independence;
- General Responsibility;
- General Behaviour;
- Life Skill – Social Development;
- Life Skill – Personal Development; and
- Life Skill – Handwriting.

The comparison between Term1 (T1) and Term3 (T3), of each of the above mentioned learning areas, will be expressed statistically by using the:

- McNemar-Bowker test for paired observations (McNemar, 1947):

  A statistical test used on pared nominal data. It is a applied to 2 X 2 contingency tables with a dichotomous trait, with matched pairs of subjects, to determine whether the row and column marginal frequencies are equal (that is, whether there is "marginal homogeneity"); and

- One-sided test for equal proportions (Moore *et al.,* 2013):

  Test performed to compare the proportion of subjects who improved between the control and experimental groups.

  Test for equal proportions where:

  P_{IT} ≡ Proportion of learners in the experimental group who improved from Term1 to Term3.

  P_{IC} ≡ Proportion of learners in the control group who improved from Term1 to Term3.

3.9 ETHICAL CONSIDERATIONS

Marczyk *et al.* (2005) states that virtually all studies with human participants involve some degree of risk. The risks can range from minor discomfort or embarrassment caused by somewhat intrusive questions to more severe effects on participants' physical and emotional well being. The researcher must be aware that these risks present his or her with an ethical dilemma as to the degree to which participants should be placed at risk in the name of scientific progress.

The conducting of research requires not only expertise and diligence, but also honesty and integrity. This is done to recognise and protect the rights of human subjects. To render the study ethical, the rights to self-determination, anonymity, confidentiality and informed consent were observed.

Permission to conduct the research study was obtained from the Department of Biokinetics, Sport and Leisure Studies and the Ethical Committee in the Faculty of

Humanities at the University of Pretoria, as well as from the principal of St. Paulus Pre- and Primary School (Appendix C – Permission letter).

Burns and Grove (1993) define informed consent as the prospective subject's agreement to participate voluntarily in a study, which is reached after assimilation of essential information about the study. The subjects were informed of their rights to voluntarily give consent or decline to participate, as well as their rights to withdraw participation at any time without penalty. The informed consent form (Appendix B) has been given to the participants (the experimental group, as well as the control group) and their parents and includes the researcher's responsibilities.

The following basic elements of informed consent will be followed:

- A fair explanation of the procedures to be followed, including an identification of those that are experimental;
- A description of the possible discomforts and risks;
- A description of the benefits to be expected;
- A disclosure of appropriate alternative procedures that would be advantageous for the participant;
- An offer to answer any enquiries concerning the procedures;
- An indication that the participant is free to withdraw consent and to discontinue participation on the project or activity at any time.
- There will be qualified first aid personnel as well as a first aid kit on hand whilst performing the required tasks.
- The rights of the participant will be considered by the researcher;
- The right to privacy or non-participation;
- The right to remain anonymous;
- The right to confidentiality; and
- The right to expect experimenter responsibility.

The following basic ethical procedures will also be followed:

- Life, health and privacy of subjects will be protected;
- Generally accepted scientific principles will be adhered to;

- Submission of the research proposal to Humanities Ethics Committee for ethical clearance; and
- If risks outweigh benefits, the research will be ceased.

Anonymity and confidentiality were maintained throughout the study. Burns and Grove (1993) define anonymity as the condition in which subjects cannot be linked, even by the researcher.

In this study anonymity was ensured by not disclosing the participant's name on the evaluation report and research reports and detaching the written consent from the evaluation report. When subjects are promised confidentiality it means that the information they provide will not be publicly reported in a way which identifies them (Polit & Hungler, 1993).

In this study, confidentiality was maintained by keeping the collected data confidential and not revealing the subjects' identities when reporting or publishing the study (Burns & Grove 1993). No identifying information was entered onto the evaluation report, and evaluation reports were only numbered after data was collected (Polit & Hungler 1993).

The ethical principle of self-determination was also maintained. Subjects were treated as autonomous agents by informing them about the study and allowing them to voluntarily choose to participate or not.

Lastly, information was provided about the researcher in the event of further questions or complaints. Scientific honesty is regarded as a very important ethical responsibility when conducting research. Dishonest conduct includes manipulation of design and methods, and retention or manipulation of data (Brink, 1996). Manipulation of data could not be done as an independent statistician entered the data from the evaluation reports. The statistician produced the results independently of the researcher to avoid subjective collaboration.

3.10 CONCLUSION

This study has been done in order to determine whether there is a significant difference in academic evaluation reports, before and after participation in specific motor learning activities.

All measurements have led to the findings of an effect on the experimental group's academic results after administration of the specific motor learning program.

In addition, this research has contributed to the explanation of specific mental processes (cognitive learning areas) that are improved by exercise and assist in an understanding of the underlying mechanisms of these improvements (Clark & Harrelson, 2002).

CHAPTER 4
RESULTS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

A randomly selected group of eighty-four (84) learners have taken part in the study. In the second term, one learner in the control group left the school during this research and has been excluded from the results. The final group consisted of eighty-three (83) learners. The experimental group (n-42) has performed a variation of specific motor learning activities (Appendix A). The number of activities has been presented and supervised by the researcher, which started in the 2nd term (April-June) of the academic year and continued until the end of the 3rd term (July-September) in the same academic year. Thereafter, a determination of improved academic learning results has taken place by comparing the 1st term (T1) academic evaluation report to that of the 3rd term (T3).

The academic evaluation reports of the experimental group have also been compared to the control group (n=41), which has not participated in the specific motor learning program; in order to eliminate possible bias caused due to the academic learning effect and adaptation throughout the course of the year.

The following academic learning areas have been evaluated:

- Afrikaans ”Lees” (reading);
- Afrikaans “Skriftelik” (writing);
- Afrikaans “Dink en Redeneer” (thinking and reasoning);
- English Write ;
- English Read;
- English Thinking and Reasoning;
- Numeracy – Numbers, Operations and Relationships;
- Numeracy – Patterns, Functions and Algebra;
- Numeracy – Data Handling;

- General Concentration;
- General Independence;
- General Responsibility;
- General Behaviour;
- Life Skill – Social Development;
- Life Skill – Personal Development; and
- Life Skill – Handwriting.

The comparison between T1 and T3, of each of the above-mentioned academic learning areas, are being expressed statistically by using the:

- McNemar-Bowker test for paired observations; and
- One-sided test for equal proportions

All the detailed results of all the academic learning areas included in this study have been copied to a cd and attached to Appendix D.

The academic learning areas discussed below were included in this chapter as they proved to be the most efficient when they were evaluated after participation in specific motor learning activities.

4.2 ACADEMIC LEARNING AREAS

Several studies have shown a positive relationship between increased physical fitness levels and academic achievement as well as fitness levels and measures of cognitive skills and attitudes (Castelli *et al.,* 2007). In addition, other studies have shown that improved motor skill levels are positively related to improvements in academic achievement (Knight & Rizzuto, 1993; Nourbakhsh, 2006; Son & Meisels, 2006) and measures of cognitive skills and attitudes (Boykin & Allen, 1988; Oja & Jürimäe, 2002; Reynolds & Nicolson, 2007).

Studies conducted in French and Canadian elementary schools over a period of four years found that regular physical activity had positive effects on academic performance. Spending one third of the school day in physical education, art, and music improved not only physical fitness, but attitudes toward learning and resultant test scores. These findings echo those from one analysis of 200 studies on the effects of exercise on cognitive functioning, which also suggests that physical activity promotes learning (Martin & Chalmers, 2007).

Battig (1979) claimed that presenting several motor tasks together in certain contexts could facilitate cognitive processes beneficial to memory improvement. He termed the difficult learning context, such as an unpredictable situation, a 'context with high contextual interference'. Performing a motor task in a difficult learning context forces the client/learner to use multiple and variable processes to overcome the difficulty of practice (Battig, 1979; Shea & Zimny, 1983). Despite its slowing of the acquisition phase, performing in a difficult context leads to the development of more elaborate and distinctive memory representations of the movements practiced, which is beneficial for retention (Battig, 1979; Shea & Zimny, 1983).

A positive relationship of physical activity and academic performance has been explored through several studies conducted in the USA by the California Department of Education (2005); Dwyer et al. (1983); Shephard (1997); Linder (1999); Dwyer *et al.* (2001); Tremblay *et al*. (2000) and Linder (2002). These studies support one another, as well as this research, in suggesting that when a substantial amount of school time is dedicated to physical activity, academic performance meets and may even exceed that of students not receiving additional physical activity (Shephard, 1997).

4.2.1 AFRIKAANS SKRIFTELIK (WRITING)

Research has shown that the body acts as a receptor for information and the medium through which knowledge is expressed. By using specific movement exercises, for reflex stimulus, various reflex abnormalities have been corrected and this has resulted in improved reading and writing activities (Goddard Blythe, 2000; Leppo *et al.,* 2000).

Muscle tone is controlled by the vestibular system and it is considered to be the amount of tension normally visible when the muscles are in a restating state. Muscle tone is required to control posture, which includes the strength needed to sit in a chair, trying to hold the neck steady for reading and writing, or to compete in sport or recreational activities. According to Kokot (2006), it is often taken for granted that the child has automatic control of the skeletal muscles in order to sit or stand still. Other requirements a child needs are to be able to stabilise the body to move an arm, leg, hand or foot independently during fine and gross motor activities.

Pyfer in Goddard Blythe (2002:59) acknowledges the impact of the proper functioning of the vestibular system on motor development as follows: "Vestibular input is necessary for static and dynamic balance development, eye tracking ability and motor planning; children who are slow to develop good vestibular functioning are delayed in all gross motor patterns which require coordination of both sides of the body. They have difficulty in maintaining posture, with eye-hand coordination and with fine motor control."

Test: McNemar-Bowker test for paired observations

A good starting point was to first determine separately – for the control and the experimental group – whether or not there was a change or shift in the performance ratings of the learners from T1 to T3. This was tested statistically by performing the McNemar-Bowker test.

McNemar's test is applied to 2 × 2 contingency tables with a dichotomous trait, with matched pairs of subjects, to determine whether the row and column's marginal frequencies are equal ("*marginal homogeneity*"). It is named after Quinn McNemar, who introduced it in 1947. In 1948 the statistician Albert Bowker expanded on McNemar's work and developed a test for symmetry that evaluates the changes in "before" and "after" responses in contingency tables where there are more than two categories (McNemar, 1947).

4.2.1a For the control group, the null and alternative hypotheses are as follows:

H0: With respect to Afrikaans Writing the learners in the Control group rated similar in T1 and T3.

H1: With respect to Afrikaans Writing the learners in the Control group did not attain the same ratings in T1 and T3.

In the contingency table (also referred to as cross tabulation) below, the test is explained in detail for the Afrikaans Writing performance ratings; first for the control (a) and then for the experimental group (b), as can be seen in Table 4.1.1a and Table 4.2.1b.

Table 4.1.1: Cross Tabulation

			Afrikaans Skryf T3			Total
			Satisfactory	**Achieved**	**Very good**	
Afrikaans Skryf T1	**Satisfactory**	Count	11	10	0	21
		% within AfrSkryf_T3	91.7%	43.5%	0.0%	52.5%
		% of Total	27.5%	25.0%	0.0%	52.5%
	Achieved	Count	1	10	0	11
		% within AfrSkryf_T3	8.3%	43.5%	0.0%	27.5%
		% of Total	2.5%	25.0%	0.0%	27.5%
	Very good	Count	0	3	5	8
		% within AfrSkryf_T3	0.0%	13.0%	100.0%	20.0%
		% of Total	0.0%	7.5%	12.5%	20.0%
Total		Count	12	23	5	40
		% within AfrSkryf_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	30.0%	57.5%	12.5%	100.0%

a. Group = Control

Below (Table 4.1.2a) the test statistic value for the McNemar-Bowker test = 10.364 and the p-value = 0.006

Table 4.1.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	10.364	2	.006
N of Valid Cases	40		

a. Group = Control

Since 0.006 < 0.05, as seen in the above (Table 4.1.2a) Chi-square test, we can reject H0 in the control group and conclude that there was a significant shift in the ratings for Afrikaans Writing between T1 and T3.

Specifically:

* 10 learners, who rated "satisfactory" in T1, were rated "achieved" in T3 (improved);
* 1 learner who rated "achieved" in T1, was rated "satisfactory" in T3 (declined); and
* 3 learners who rated "very good" in T1 were rated "achieved" in T3 (declined).

In summary, out of the 40 learners, 10 showed an improvement (in T3, they obtained a higher rating than the one they had attained in T1) and 4 learners showed a decline (in T3, they obtained a lower rating than the one they had attained in T1). If these numbers were expressed in terms of percentages, it shows that the rating of 25% of the learners improved and 10% declined from T1 to T3, while the rating of 65% stayed the same.

4.2.1b For the experimental group the contingency Table 4.2.1b and Table 4.2.2b are as follows:

Since 0.001 < 0.05, as seen in the (Table 4.2.2b) Chi-square test below, we can reject H0 in the experimental group and conclude that for the experimental group there was a significant shift in the ratings for Afrikaans Writing between T1 and T3.

Table 4.2.1: Cross tabulation

			Afrikaans Skryf T3			Total
			Satisfactory	Achieved	Very good	
Afrikaans Skryf T1	Satisfactory	Count	8	14	0	22
		% within AfrSkryf_T3	100.0%	43.8%	0.0%	53.7%
		% of Total	19.5%	34.1%	0.0%	53.7%
	Achieved	Count	0	16	1	17
		% within AfrSkryf_T3	0.0%	50.0%	100.0%	41.5%
		% of Total	0.0%	39.0%	2.4%	41.5%
	Very good	Count	0	2	0	2
		% within AfrSkryf_T3	0.0%	6.3%	0.0%	4.9%
		% of Total	0.0%	4.9%	0.0%	4.9%
Total		Count	8	32	1	41
		% within AfrSkryf_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	19.5%	78.0%	2.4%	100.0%

a. Group = Experimental

Test Statistic value = 14.333 and the p-value = 0.001

Table 4.2.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	14.333	2	.001
N of Valid Cases	41		

a. Group = Experimental

Children need to experience orienting their bodies in space by going up, on, under beside, inside, and in front of things. Should they not be subjected to spatial orientation, it is possible they will have difficulty dealing with the letter identification and orientation of symbols on a page. The difference between p, b and d depends on orientation in space. All are composed of a line and a circle. It depends on which side of the circle the line is. Motor movements serve to promote sensory integration. Movement also provides the opportunity to learn left and right, which is crucial to reading and writing. A child who does not know left from right will not know where to start reading, could skip lines and stop in the middle of the sentence (Corso, 1993; Burn, 2007).

Specifically, the result of the experimental group reflects:

- 14 learners who rated “satisfactory” in T1, were rated “achieved in T3 (Improved);
- 1 learner who rated “achieved” in T1, was rated “very good” in T3 (Improved); and
- 2 learners who rated “very good” in T1, were rated “achieved” in T3 (Declined).

Out of the 41 learners, the rating of 15 learners showed an improvement and that of 2 learners showed a decline. In terms of percentages, 36.6% of the learners obtained improved ratings in T3, 4.9% attained lower ratings in T3, while the ratings of 58.5% stayed the same.

Movement in space using the whole body forms the foundation for school readiness tasks like reading, writing and mathematics. The concept of space and the position in space is not something that can be taught to a child. A child has to experience position in space through movement. As in the example already given, *p*, *b* and *d* are all the same shape, only their positions differ. The teacher is the mediator in providing the child with spatial experiences (Corso, 1993).

4.2.2 The extent of the ratings in Table 4.3a and Table 4.3b, hereunder, concludes that participation in specific motor learning activities for a period of time will result in an improvement in the academic area – Afrikaans Skryf (Writing).

Table 4.3a: Comparison in terms of percentages

Afrikaans Writing	Control Group	Experimental Group
Decline	10	4.9
Stayed the same	25	58.5
Improved	65	36.6
	100	100

Test performed to compare the proportion of subjects who improved between the control and experimental groups.

Test for equal proportions where:

P_{IT} ≡ Proportion of learners in experimental group who improved from T1 to T3.

P_{IC} ≡ Proportion of learners in control group who improved from T1 to T3.

Table 4.3b: One sided-test for equal proportions

Afrikaans Writing	Improved	Not improved / Stayed the same	Total	Observed value of statistic	P – value
Control	10	30	40		
Experimental	15	26	41	-1.12852236	0.12955

The vestibular and auditory systems are further developed through physical activity. Miller (2006) explains that the vestibular and the auditory systems both work together as they process sensations of movement and sound. The profound influence of the ear on physical development is acknowledged. Not only is it vital for hearing, balance and flexibility but also for bilateral coordination, breathing, speaking, vision, social relationships, as well as academic learning.

The above (Table 4.3b) one sided-test for equal proportions infers that the proportion of learners in the control group who improved is smaller than the proportion of learners in the experimental group who have improved from T1 to T3. It can thus be concluded that participating in a specific motor learning program does improve a learners' Afrikaans Skryf (Write).

4.2.2 ENGLISH WRITE

According to Calitz (1997), topology refers to the internal map of each child's surroundings. In the beginning it is constructed by the young child's knowledge of the concrete surroundings. Jensen (2000b) states that movement gives a child a new spatial reference and thus enhances spatial learning. The brain forms maps of the body's relationship to the scenery. The function of this concept is to help children with knowledge of direction and knowledge of position in space as well as forming an important ingredient of problem solving. Knowledge of direction includes, up, down, around, under (Calitz, 1997); all of which were included in the motor learning activities presented to the experimental group. This knowledge is essential within the classroom setup, especially when calculation, writing and reading takes place.

For the control group the null and alternative hypotheses are as follows:

- H0: With respect to English Write the learners in the Control group rated similar in T1 and T3.
- H1: With respect to English Write the learners in the Control group did not attain the same ratings in T1 and T3.

In the contingency table (also referred to as cross tabulation) below, the test is explained in detail for the English Writing performance ratings – first for the control (a) and then for the experimental group (b) – as can be seen in Table 4.4.1a and Table 4.5.1b.

Since 0.042 < 0.05, we can conclude that there was a significant shift in the ratings for English Write between T1 and T3.

In summary, out of the 40 learners, 3 showed an improvement (in T3, they obtained a higher rating than the one they had attained in T1) and 10 learners showed a decline (in T3, they obtained a lower rating than the one they had attained in T1).

Table 4.4.1: Cross tabulation

			English Write T3				Total
			Very poor	Satisfactory	Achieved	Very good	
English Write T1	Very poor	Count	1	0	0	0	1
		% within EngWrite_T3	100.0%	0.0%	0.0%	0.0%	2.4%
		% of Total	2.4%	0.0%	0.0%	0.0%	2.4%
	Satisfactory	Count	0	8	1	0	9
		% within EngWrite_T3	0.0%	100.0%	3.8%	0.0%	22.0%
		% of Total	0.0%	19.5%	2.4%	0.0%	22.0%
	Achieved	Count	0	0	15	2	17
		% within EngWrite_T3	0.0%	0.0%	57.7%	33.3%	41.5%
		% of Total	0.0%	0.0%	36.6%	4.9%	41.5%
	Very good	Count	0	0	10	4	14
		% within EngWrite_T3	0.0%	0.0%	38.5%	66.7%	34.1%
		% of Total	0.0%	0.0%	24.4%	9.8%	34.1%
Total		Count	1	8	26	6	41
		% within EngWrite_T3	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	2.4%	19.5%	63.4%	14.6%	100.0%

a. Group = Control

Test statistic value for the McNemar-Bowker test = 6.333 and the p-value = 0.042

Table 4.4.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	6.333	2	.042
N of Valid Cases	41		

a. Group = Control

If these numbers were expressed in terms of percentages it follows that the rating of 7.32% of the learners improved and 24.39% declined from T1 to T3, while the rating of 68.29% stayed the same.

For the experimental group the contingency Table 4.5.1b and Table 4.5.2b are as follows:

Table 4.5.1: Cross tabulation

			English Write T3			Total
			Satisfactory	Achieved	Very good	
English Write T1	Satisfactory	Count	5	6	0	11
		% within EngWrite_T3	71.4%	21.4%	0.0%	26.8%
		% of Total	12.2%	14.6%	0.0%	26.8%
	Achieved	Count	2	16	3	21
		% within EngWrite_T3	28.6%	57.1%	50.0%	51.2%
		% of Total	4.9%	39.0%	7.3%	51.2%
	Very good	Count	0	6	3	9
		% within EngWrite_T3	0.0%	21.4%	50.0%	22.0%
		% of Total	0.0%	14.6%	7.3%	22.0%
Total		Count	7	28	6	41
		% within EngWrite_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	17.1%	68.3%	14.6%	100.0%

a. Group = Experimental

Test Statistic value = 3.000 and the p-value = 0.223

Table 4.5.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	3.000	2	.223
N of Valid Cases	41		

a. Group = Experimental

Since 0.223 > 0.05, we can conclude that for the experimental group there was a significant shift in the ratings for English Write between T1 and T3. Out of the 41 learners, the rating of 9 learners showed an improvement and that of 8 learners showed a decline. In terms of percentages, 36.6% of the learners obtained improved ratings in T3, 4.9% attained lower ratings in T3, while the ratings of 58.5% stayed the same.

As mentioned in Calitz (1997) numerous experiences in moving, kicking and throwing will help with writing. The ability to follow an object in space is important when it comes to following a written line from left to right and back to left, as well as to continue with the following line. This action is required for reading and written work. Movement also provides the opportunity to learn left and right, which is crucial to reading and writing (Corso, 1993; Burn, 2007). Certain movement activities provide the opportunity for children to enhance crossing the midline (Corso, 1993).

The extent of the ratings in Table 4.6a and Table 4.6b, hereunder, concludes that participation in specific motor learning activities for a period of time will result in an improvement in the academic area – English Writing. Just the same as the following studies, the first study was done to promote physical activity to diminish obesity in elementary school children. Not only did the trial show success in overweight individuals but improvements in composite, reading, math, and spelling (Donnelly *et al*., 2010). Another investigation to combat obesity, found that low aerobic fitness is common among youth and varies among ethnic groups, and aerobic fitness level predicts performance on standardized math, reading and language tests across ethnic groups (Roberts *et al*., 2011).

Table 4.6a: Comparison in terms of percentages

ENGLISH WRITE	**Control Group**	**Experimental Group**
Decline	24.39	19.51
Stayed the same	68.29	58.54
Improved	7.32	21.95
	100	100

Test performed to compare the proportion of subjects who improved between the control and experimental groups.

Table 4.6b: One sided-test for equal proportions

English Write	Improved	Not improved	Total	Observed value of statistic	P – value
Control	3	38	41		
Experimental	9	32	41	**-1.87464282**	**0.03042***

The above Table 4.6b infers that the proportion of learners in the control group who improved is smaller than the proportion of learners in the experimental group who have improved from T1 to T3 in the academic learning area – English Write.

With respect to the writing academic learning areas (both Afrikaans and English) an agreement can be made that, experiences in movement help with the development of focusing, that is, keeping an eye on the ball until it is caught. Ocular motility is therefore required. This motor skill is also required in drawing, reading and writing exercises (Kokot, 2006).

With the detailed discussion as well as mentioning the above studies, it can be concluded that organized motor learning activities administered on a regular basis have a successful outcome on academic learning areas, specifically Afrikaans and English Writing.

4.2.3 NUMERACY

Preliminary results from a series of studies (Ismail & Gruber, 1971; Dwyer *et al*. 2001) undertaken with elementary school children do indicate a strong relationship between academic achievement and fitness scores. One study found that physically fit children identified visual stimuli faster. Brain activation patterns provided evidence that the fit children allocated more cognitive resources towards the task, as well as processing information faster (Battro & Fischer, 2006). Without placing emphasis on physically fit children, physically active children will most likely show a positive change in their academic work – as can be seen below in a detailed discussion of "Patterns, functions and algebra"; one of three categories in the learning area Numeracy (also known as math).

4.2.3.1 PATTERNS, FUNCTIONS AND ALGEBRA

Movement assists with the skills of problem solving that are acquired on the basic concrete level in the early years. Exploration of the environment and creative problem solving forms an important part of the cognitive thinking process. Young children solve problems by trial and error (Calitz, 1997). Climbing trees, building puzzles and packing blocks are some of the activities, which help acquire and develop the necessary problem solving skills required for learning.

For the control group the null and alternative hypotheses are as follows:

H0: With respect to Numeracy – Patterns, Functions and Algebra (NUM – PFA) the learners in the Control group rated similar in T1 and T3.

H1: With respect to NUM – PFA the learners in the Control group did not attain the same ratings in T1 and T3.

Table 4.7: Cross tabulation

			Numeracy PFA T3			Total
			Satisfactory	Achieved	Very good	
Numeracy PFA T1	Very poor	Count	1	0	0	1
		% within NumPat_T3	50.0%	0.0%	0.0%	2.4ƒ%
		% of Total	2.4%	0.0%	0.0%	2.4%
	Achieved	Count	1	10	10	21
		% within NumPat_T3	50.0%	90.9%	35.7%	51.2%
		% of Total	2.4%	24.4%	24.4%	51.2%
	Very good	Count	0	1	18	19
		% within NumPat_T3	0.0%	9.1%	64.3%	46.3%
		% of Total	0.0%	2.4%	43.9%	46.3%
Total		Count	2	11	28	41
		% within NumPat_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	4.9%	26.8%	68.3%	100.0%

a. Group = Control

In the contingency table (also referred to as cross tabulation) above, the test is explained in detail for the Numeracy Patterns, Functions and Algebra performance ratings (hereafter referred to as Numeracy PFA), first for the control (a) and then for the experimental group (b); as can be seen in Table 4.7.1a and Table 4.8.1b.

In summary, out of the 41 learners, 10 showed an improvement (in T3, they obtained a higher rating than the one they had attained in T1) and 3 learners showed a decline (in T3, they obtained a lower rating than the one they had attained in T1).

If these numbers were expressed in terms of percentages it shows that the rating of 24.39% of the learners improved and 4.88% declined from T1 to T3, while the rating of 70.73% stayed the same.

For the experimental group the contingency Table 4.8.1b and Table 4.8.2b are as follows:

Table 4.8.1: Cross tabulation

			Numeracy PFA T3			**Total**
			Satisfactory	**Achieved**	**Very good**	
Numeracy PFA T1	Satisfactory	Count	2	2	0	4
		% within NumPat_T3	66.7%	13.3%	0.0%	9.5%
		% of Total	4.8%	4.8%	0.0%	9.5%
	Achieved	Count	1	11	10	22
		% within NumPat_T3	33.3%	73.3%	41.7%	52.4%
		% of Total	2.4%	26.2%	23.8%	52.4%
	Very good	Count	0	2	14	16
		% within NumPat_T3	0.0%	13.3%	58.3%	38.1%
		% of Total	0.0%	4.8%	33.3%	38.1%
Total		Count	3	15	24	42
		% within NumPat_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	7.1%	35.7%	57.1%	100.0%

a. Group = Experimental

Test Statistic value = 5.667 and the p-value = 0.059

Table 4.8.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	5.667	2	.059
N of Valid Cases	42		

a. Group = Experimental

Since 0.59 > 0.05, we conclude that for the experimental group there was a significant shift in the ratings for NUM – PFA between T1 and T3. This has also been the case in a study done at The University of Eastern Finland, where researches assessed the activity levels and reading and math skills of 186 Finnish children in grades 1 to 3. They reported a link between higher levels of physical activity at recess and better reading skills, and a connection between participation in organized sports and higher math test scores (Haapala *et al*., 2014).

In terms of percentages 28.57% of the learners obtained improved ratings in T3, 7.14% attained lower ratings in T3, while the ratings of 64.29% stayed the same.

The extent of the ratings in Table 4.9a and Table 4.9b, hereunder, conclude that participation in specific motor learning activities for a period of time will result in an improvement in the academic area – Numeracy PFA. According to Dr. Carla Hannaford, author of Smart Moves: "The more closely we consider the elaborate interplay of brain and body, the more clearly one compelling theme emerges: movement is essential to learning. Movement awakens and activates our mental capacities. Movement integrates and anchors new information and experience into our neural networks. Moving while learning increases learning." (Hannaford, 2007)

The Table 4.9b below infers that the proportion of learners in the control group who improved is not similar to the proportion of learners in the experimental group who have improved from T1 to T3 in the academic learning area Numeracy – Patterns, functions and algebra. By this statement, a conclusion can be made that by participating in specific motor learning activities over a period of time will improve, more specifically, Numeracy PFA. Just as mentioned by Eric Jensen (2000b: 34) who wrote "Research suggests that physical activity benefits learning. Movement increases heart rate and circulation, enhances spatial learning, provides a break from learning, allows cognitive maturation, stimulates the release of beneficial chemicals, counteracts excessive sitting, and affirms the value of implicit learning."

Table 4.9a: Comparison in terms of percentages

	Control Group	Experimental Group
NUMERACY PFA		
Decline	4.88	7.14
Stayed the same	70.73	64.29
Improved	24.39	28.57
	100	100

Table 4.9b: One sided-test for equal proportions

NUMERACY PFA	Improved	Not improved	Total	Observed value of statistic	P – value
Control	10	31	41		
Experimental	12	30	42	-0.17729814	0.42964

4.2.4.1 GENERAL – CONCENTRATION

A study has shown that physical activity has positive influences on concentration, memory and classroom behaviour. Data from quasi-experimental studies found support in mechanistic experiments on cognitive function, pointing to a positive relationship between physical activity and intellectual performance (Trudeau & Shepard, 2008). With the focus on the academic learning area "Concentration", the hypotheses for the control group are as follows:

H_0: With respect to General – Concentration (GEN – CON) the learners in the Control group rated similar in T1 and T3.

H_1: With respect to GEN – CON the learners in the Control group did not attain the same ratings in T1 and T3.

In the contingency table (also referred to as cross tabulation) below, the test is explained in detail for the General Concentration performance ratings (hereafter referred to as GEN - CON), first for the control (a) and then for the experimental group (b); as can be seen in Table 4.10.1a and Table 4.11.1b.

Table 4.10.1: Cross tabulation

			Concentration Tern 3			Total
			Satisfactory	Achieved	Very good	
Concentration T1	Satisfactory	Count	5	4	0	9
		% within Conc_T3	100.0%	19.0%	0.0%	22.0%
		% of Total	12.2%	9.8%	0.0%	22.0%
	Achieved	Count	0	16	6	22
		% within Conc_T3	0.0%	76.2%	40.0%	53.7%
		% of Total	0.0%	39.0%	14.6%	53.7%
	Very good	Count	0	1	9	10
		% within Conc_T3	0.0%	4.8%	60.0%	24.4%
		% of Total	0.0%	2.4%	22.0%	24.4%
Total		Count	5	21	15	41
		% within Conc_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	12.2%	51.2%	36.6%	100.0%

a. Group = Control

Test statistic value for the McNemar-Bowker test = 7.571 and the P – value = 0.023

Table 4.10.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	7.571	2	.023
N of Valid Cases	41		

a. Group = Control

Since 0.023 < 0.05, we can reject H_0 and conclude that there was a significant shift in the ratings for GEN – CON between T1 and T3.

Specifically: *4 learners who rated "satisfactory" in T1, were rated "achieved" in T3 (improved).

*6 learners who rated "achieved" in T1, were rated "very good" in T3 (improved).

*1 learner who rated "very good" in T1, was rated "achieved" in T3 (declined).

If these numbers were expressed in terms of percentages, it shows that the rating of 24.39% of the learners improved and 2.44% declined from T1 to T3, while the rating of 73.17% stayed the same.

According to Hannaford (2005), on entering school, children are often expected to develop their focus quickly in order to see small, static, two-dimensional letters on paper. The transition from three dimensional (working with shapes in preschool) and peripheral focus is very abrupt and in many cases unnatural. In order to catch a beanbag, write in a specific place or read a word, a child needs to focus on a specific point and keep his or her focus/concentration until the task is completed. Experiences in movement help with the development of focus/concentration allowing the child to, keep an eye on the ball until it is caught. Ocular motility is therefore required (Kokot, 2006). From the movement experienced from the specific motor learning program that comprised of hand-eye coordination and foot-eye coordination – both skills included activities with different balls and different implements (such as a hockey stick) – the results of the experimental group below illustrates the positive relationship between physical activity and concentration.

For the experimental group the contingency Table 4.11.1b and Table 4.11.2b are as follows:

Table 4.11.1: Cross tabulation

			Concentration T3			Total
			Satisfactory	Achieved	Very good	
Concentration T1	Satisfactory	Count	5	8	0	13
		% within Conc_T3	83.3%	38.1%	0.0%	31.0%
		% of Total	11.9%	19.0%	0.0%	31.0%
	Achieved	Count	1	12	6	19
		% within Conc_T3	16.7%	57.1%	40.0%	45.2%
		% of Total	2.4%	28.6%	14.3%	45.2%
	Very good	Count	0	1	9	10
		% within Conc_T3	0.0%	4.8%	60.0%	23.8%
		% of Total	0.0%	2.4%	21.4%	23.8%
Total		Count	6	21	15	42
		% within Conc_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	14.3%	50.0%	35.7%	100.0%

a. Group = Experimental

Test Statistic value = 9.016 and the P – value = 0.011

Table 4.11.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	9.016	2	.011
N of Valid Cases	42		

a. Group = Experimental

Since 0.011 < 0.05, we can reject H_0 and conclude that for the experimental group there was a significant shift in the ratings for Gen - Con between T1 and T3.

Out of the 42 learners, the rating of 14 learners showed an improvement and that of 2 learners showed a decline:

In terms of percentages, 33.33% of the learners obtained improved ratings in T3, 4.76% attained lower ratings in T3, while the ratings of 61.9% stayed the same.

The extent of the ratings in Table 4.12a and Table 4.12b, hereunder, conclude that participation in specific motor learning activities for a period of time will result in an improvement in the academic area – GEN - CON.

Table 4.12a: Comparison in terms of percentages

GEN – CON	Control Group	Experimental Group
Decline	2.44	4.76
Stayed the same	73.17	61.9
Improved	24.39	33.33
	100	99.99

Table 4.12b: One sided-test for equal proportions

GEN - CON	Improved	Not improved / Stayed the same	Total	Observed value of statistic	P – value
Control	10	31	41		
Experimental	14	28	42	-0.89848652	0.18446

The above Table 4.12b infers that the proportion of learners in the control group who improved is smaller than the proportion of learners in the experimental group who have improved from T1 to T3 in the academic learning area, General - Concentration. This relates to studies that have shown that physical activity can increase neural activity in the brain. Exercise specifically increases executive brain functions such as attention span/concentration and working memory (Tomporowski *et al.,* 2008).

4.2.4.2 GENERAL – BEHAVIOUR

Academic behaviours include a range of behaviours that may have an impact on students' academic performance. Common indicators include on-task behaviour, organization, planning, attendance, scheduling, and impulse control. Students with poor impulse control have more difficulty motivating themselves to study, do homework and listen in class. This can decrease their ability to excel academically, even when they perform well on IQ and achievement tests. Wang and Aamodt (2011) emphasize that rule-setting and teaching frustration tolerance play critical roles in helping children develop impulse control.

Given the ever-increasing demands to assess children in the elementary school, the relative scheduling of physical education class is a concern for school administrators and teachers. The time of day to schedule physical education to minimize the possible influence on testing or classroom learning has been a concern, but quantitative data are limited, and even theoretical discussion has often not involved the elementary school population. The hypotheses for the control group are as follows:

H_0: With respect to General – Behaviour (GEN - BEH) the learners in the Control group rated similar in T1 and T3.

H_1: With respect to GEN - BEH the learners in the Control group did not attain the same ratings in T1 and T3.

In the contingency table (also referred to as cross tabulation) below, the test is explained in detail for the General – Behaviour performance ratings (hereafter referred to as GEN - BEH), first for the control (a) and then for the experimental group (b), as can be seen in Table 4.13.1a and Table 4.14.1b.

Since 0.549 > 0.05, we can reject H0 and conclude that there was a significant shift in the ratings for GEN - BEH between T1 and T3.

In summary, out of the 41 learners, 5 showed an improvement (in T3, they obtained a higher rating than the one they had attained in T1) and 4 learners showed a decline (in T3, they obtained a lower rating than the one they had attained in T1).

Table 4.13.1: Cross tabulation

			Behaviour T3			Total
			Satisfactory	Achieved	Very good	
Behaviour T1	Satisfactory	Count	1	2	0	3
		% within Beh_T3	25.0%	14.3%	0.0%	7.3%
		% of Total	2.4%	4.9%	0.0%	7.3%
	Achieved	Count	3	11	3	17
		% within Beh_T3	75.0%	78.6%	13.0%	41.5%
		% of Total	7.3%	26.8%	7.3%	41.5%
	Very good	Count	0	1	20	21
		% within Beh_T3	0.0%	7.1%	87.0%	51.2%
		% of Total	0.0%	2.4%	48.8%	51.2%
Total		Count	4	14	23	41
		% within Beh_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	9.8%	34.1%	56.1%	100.0%

a. Group = Control

Test statistic value for the McNemar-Bowker test = 1.200 and the P – value = 0.54

Table 4.13.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	1.200	2	.549
N of Valid Cases	41		

a. Group = Control

One area in which physical exercise has been viewed as increasingly beneficial and not causing educational interference is in the counselling literature. According to

Scherman (1989), stress interferes with school performance but physical activity reduces stress and enhances positive attitudes. The use of exercise to positively promote emotional health has been reported for children with disruptive behaviour. This positive effect can also been seen below by the contingency tables (Table 4.14.1b and Table 4.14.2b) for the experimental group:

Table 4.14.1: Cross tabulation

			Behaviour T3			Total
			Satisfactory	Achieved	Very good	
Behaviour T1	Satisfactory	Count	2	1	0	3
		% within Beh_T3	33.3%	14.3%	0.0%	7.1%
		% of Total	4.8%	2.4%	0.0%	7.1%
	Achieved	Count	4	5	8	17
		% within Beh_T3	66.7%	71.4%	27.6%	40.5%
		% of Total	9.5%	11.9%	19.0%	40.5%
	Very good	Count	0	1	21	22
		% within Beh_T3	0.0%	14.3%	72.4%	52.4%
		% of Total	0.0%	2.4%	50.0%	52.4%
Total		Count	6	7	29	42
		% within Beh_T3	100.0%	100.0%	100.0%	100.0%
		% of Total	14.3%	16.7%	69.0%	100.0%

a. Group = Experimental

Test Statistic value = 7.244 and the P – value = 0.027

Table 4.14.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
McNemar-Bowker Test	7.244	2	.027
N of Valid Cases	42		

a. Group = Experimental

Since 0.027 < 0.05, we can reject H_0 and conclude that for the experimental group there was a significant shift in the ratings for GEN - BEH between T1 and T3.
Out of the 42 learners, the rating of 9 learners showed an improvement and that of 5 learners showed a decline.

Carlson (1982) wrote of the multimodal effect of counseling and the benefits of physical exercise in enhancing emotional, cognitive, social, imaginative and behavioural processes of the child (Catering & Polak, 1999). The extent of the ratings in Table 4.15a and Table 4.15b, hereunder, concludes that participation in specific motor learning activities for a period of time will result in an improvement in the academic area – GEN - BEH.

Table 4.15a: Comparison in terms of percentages

GEN - BEH	Control Group	Experimental Group
Decline	9.76	11.9
Stayed the same	78.04	66.67
Improved	12.19	21.43
	99.99	100

Test performed to compare the proportion of subjects who improved between the control and experimental groups.

Table 4.15b: One sided-test for equal proportions

GEN - BEH	Improved	Not improved / Stayed the same	Total	Observed value of statistic	P – value
Control	5	36	41		
Experimental	9	33	42	-0.91710723	0.17954

In a 2007 report from the American Academy of Pediatrics, it was stated that play promotes not only behavioural development, but also brain growth (Frost *et al.,* 2005). The University of North Carolina's Abecedarian Early Child Intervention program found that children who received an enriched, play-oriented parenting and early childhood program had significantly higher IQ's at age five than that of a comparable group of children who were not in the program (Barnett, 1995). The above Table 4.15b infers that the proportion of learners in the control group who improved is smaller than the proportion of learners in the experimental group who have improved from T1 to T3 in the academic learning area, General - Behaviour.

Thus a conclusion can be made that physical activity has a positive influence on concentration and memory (Klein & Deffenbacher, 1977; Zervas et al. 1991; McNaughten & Babbard, 1993; Caterino & Polak, 1999; Garnier *et al.*, 2000; Brisswalter *et al*., 2002; Graf *et al*., 2003; Reynolds *et al*. 2003; Tomporowsi, 2003;) and on classroom behaviour (Shephard, 1997).

4.2.5.1 LIFE SKILLS – SOCIAL DEVELOPMENT

New research suggests that physical activity can help adolescent children develop important skills such as leadership and empathy. In turn, these skills can influence healthy behaviours. This research shares the point of view of the mentioned research as it indicates that physical activity has a positive effect on social development.

For the control group the null and alternative hypotheses are as follows:

H_0: With respect to Life Skills – Social Development (LS – SD) the learners in the Control group rated similar in T1 and T3.

H_1: With respect to LS – SD the learners in the Control group did not attain the same ratings in T1 and T3.

In the contingency table (also referred to as cross tabulation) below, the test is explained in detail for the Life Skills – Social Development performance ratings (hereafter referred to as LS – SD), first for the control (a) and then for the experimental group (b), as can be seen in Table 4.16.1a and Table 4.17.1b.

Since 0.246 > 0.05, we can reject H0 and conclude that there was a significant shift in the ratings for LS – SD between T1 and T3.

In terms of percentages it shows that the rating of 13.51% of the learners improved and 10.81% declined from T1 to T3, while the rating of 75.68% stayed the same.

Table 4.16.1: Cross tabulation

			Life Skills – Social Development T3		Total
			Achieved	**Very good**	
Life Skills – Social Development T1	**Achieved**	Count	24	5	29
		% within LSSD_T3	85.7%	55.6%	78.4%
		% of Total	64.9%	13.5%	78.4%
	Very good	Count	4	4	8
		% within LSSD_T3	14.3%	44.4%	21.6%
		% of Total	10.8%	10.8%	21.6%
Total		Count	28	9	37
		% within LSSD_T3	100.0%	100.0%	100.0%
		% of Total	75.7%	24.3%	100.0%

a. Group = Control

P – value = 0.246

Table 4.16.2: Chi-Square Tests

	Value	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
McNemar Test		1.000[b]	.500[b]	.246[b]
N of Valid Cases	37			

a. Group = Control

b. Binomial distribution used.

Researchers at the University of Michigan gathered physiological data (height, weight, blood pressure, blood glucose and cholesterol) and responses to questionnaires on diet, exercise, leadership and empathy from 709 public school children in sixth grade. Children were then divided into groups by leadership and the three groups were compared with each other. Middle school children who scored highest in leadership skills were more physically active (≥ 20 min/day) on a weekly basis (4.71 days ± 2.11 days). These children were also able to show high scores in empathy. Moderate exercise (≥ 30 min/day) and participation in team sports also correlated with higher leadership and empathy scores (Nauert, 2010). The evaluation of social development has shown an effective outcome after participation in the motor learning program as seen in the contingency tables. For the experimental group the contingency Table 4.17.1b and Table 4.17.2b are as follows:

Table 4.17.1: Cross tabulation

			Life Skills – Social Development T3		Total
			Achieved	Very good	
Life Skills – Social Development T1	**Achieved**	Count	29	2	31
		% within LSSD_T3	85.3%	50.0%	81.6%
		% of Total	76.3%	5.3%	81.6%
	Very good	Count	5	2	7
		% within LSSD_T3	14.7%	50.0%	18.4%
		% of Total	13.2%	5.3%	18.4%
Total		Count	34	4	38
		% within LSSD_T3	100.0%	100.0%	100.0%
		% of Total	89.5%	10.5%	100.0%

a. Group = Experimental

P – value = 0.164

Table 4.17.2: Chi-Square Tests

	Value	**Exact Sig. (2-sided)**	**Exact Sig. (1-sided)**	**Point Probability**
McNemar Test		.453[b]	.227[b]	.164[b]
N of Valid Cases	38			

a. Group = Experimental

b. Binomial distribution used.

Since 0.164 > 0.05, we can reject H_0 and conclude that for the experimental group there was a significant shift in the ratings for LS – SD between T1 and T3.

In terms of percentages, 5.26% of the learners obtained improved ratings in T3, 13.16% attained lower ratings in T3, while the ratings of 81.58% stayed the same.

Students have social goals that influence their motivation alongside academic goals. These social goals are addressed during any sporting activity – organised or during play. Urdan and Maehr (1995) describe four types of social goals: social approval, social compliance, social solidarity, and social concern. Research involving qualitative methods has suggested that social goal orientations are associated with academic achievement (Kaplan & Maehr, 2002). While the social affiliation orientation is usually also considered detrimental to students' work habits, students in this study said working with their peers helped engender a sense of belonging but also helped them work more effectively and promoted positive feelings toward learning. Only sometimes would working with other students lead the students off task. Students with a social responsibility goal orientation were motivated by a desire to fulfil their role expectations. These included parent, teacher, and peer expectations (such as participating in extracurricular activities, helping the class as a whole or individual students, and behaving responsibly when holding an important student government position). Students felt proud, excited, and satisfied when they met these expectations (Dowson & McInerney, 2001). The extent of the ratings in Table 4.18a and Table 4.18b, hereunder, concludes that participation in specific motor learning activities for a period of time will result in an achieved outcome in the academic area – LS – SD.

Table 4.18a: Comparison in terms of percentages

LS – SD	**Control Group**	**Experimental Group**
Decline	10.81	13.16
Stayed the same	75.68	81.58
Improved	13.51	5.26
	100	100

Test performed to compare the proportion (Table 4.18a) of subjects who improved between the control and experimental groups.

Table 4.18b: One sided-test for equal proportions

LS – SD	Improved	Not improved / Stayed the same	Total	Observed value of statistic	P – value
Control	6	35	41		
Experimental	6	36	42	0.045128815	0.518

The self-significance theory, which is not well tested, suggests that when an individual participates in physical activity, that participation is characterized by society as 'good'; thus, exercise provides a sense of self-discipline, control and competence. It may also give the subject a sense of self-significance through the experience of reaching goals and overcoming obstacles (Rowland, 1990). The above table (Table 4.18b) reflects this self-significance (of both the control and the experimental group) and infers that the proportion of learners in the control group who improved is equal to the proportion of learners in the experimental group who have improved from T1 to T3 in the academic learning area – LS – SD.

Physical play is important to our emotional well being. Studies show that regular physical activity in childhood and adolescence reduces stress and improves self-esteem. Although good self-esteem is important in all children, obese children are at particular risk for having poor self-esteem and being rejected by peers. Most studies suggest that exercise programs are related to improvements in the self-esteem scores of participants (Sage, 1986). We are physical beings, and as such we need to move. Each culture has accepted forms of play. Children who do not learn to participate in the accepted forms of play of their culture are at a disadvantage socially as children and later as adults (Rink *et al*., 2010). Therefore, the social aspect of certain physical activities helps to develop a child's sense of camaraderie, and teaches them positive values.

4.2.5.2 LIFE SKILLS – PERSONAL DEVELOPMENT

Olds (1994) considers movement and action as essential to children's development in general and to intellectual development in particular. Movement is seen as the gateway to sensing, acting upon and being affected by the world around us. She further states that, according to Piaget, movement is essential to the formation of intellect. Piaget refers to the first stage of intellectual development as the sensory motor stage. This is when children experience the world primarily through their senses and motoric abilities. According to Olds (1994), Piaget argued that the sensory motor stage is the basis on which the subsequent hierarchy of all intelligence is built. Between birth and five or six years, children's bodies, as well as their minds, are the organ of intelligence. De Jager (2009) agrees with the previous statements and adds that babies 'talk' through movement. During the sensory-motor process the far senses (touch, smell, taste, sight, and hearing) and the near senses (vestibular, proprioceptive and kinaesthetic systems) are developed through movement.

This study has found the following for the control group, the null and alternative hypotheses are as follows:

H_0: With respect to Life Skills – Personal Development (LS – PD) the learners in the Control group rated similar in T1 and T3.

H_1: With respect to LS – PD the learners in the Control group did not attain the same ratings in T1 and T3.

In the contingency table (also referred to as cross tabulation) below, the test is explained in detail for the Life Skills – Personal Development performance ratings (hereafter referred to as LS - PD), first for the control (a) and then for the experimental group (b), as can be seen in Table 4.19.1a and Table 4.20.1b.

Physical activity may have the potential for personal growth in qualities including persistence, deeper self-reliance, commitment and motivation, and may increase resourcefulness (Weis & Frazer, 1995). This is probably truer for non-competitive physical activities than team competition. The attribution theory addresses students' sense of competence, specifically how students are affected by their previous performance. It suggests that students are more influenced by their perceptions of what caused their earlier successes and failures than by the actual experience (Anderman & Midgley, 1997).

Table 4.19: Cross tabulation

			Life Skills – Personal Development T3		Total
			Achieved	Very good	
Life Skills – Personal Development T1	Satisfactory	Count	1	0	1
		% within LSPD_T3	4.2%	0.0%	2.4%
		% of Total	2.4%	0.0%	2.4%
	Achieved	Count	20	9	29
		% within LSPD_T3	83.3%	52.9%	70.7%
		% of Total	48.8%	22.0%	70.7%
	Very good	Count	3	8	11
		% within LSPD_T3	12.5%	47.1%	26.8%
		% of Total	7.3%	19.5%	26.8%
Total		Count	24	17	41
		% within LSPD_T3	100.0%	100.0%	100.0%
		% of Total	58.5%	41.5%	100.0%

a. Group = Control

Specifically: *1 learner who rated "satisfactory" in T1, was rated "achieved" in T3 (improved).

*9 learners who rated "achieved" in T1, were rated "very good" in T3 (improved).

*3 learners who rated "very good" in T1 were rated "achieved" in T3 (declined).

In summary, out of the 41 learners, 10 showed an improvement (in T3, they obtained a higher rating than the one they had attained in T1) and 3 learners showed a decline (in T3, they obtained a lower rating than the one they had attained in T1).

There are some more theories, proposed as an explanation. These theories include the following:

- the surplus energy theory (excess energy needs to be spent, and activity allows subjects to 'blow off steam') (Rowland, 1990);
- the stimulus-seeking theory (the excitement and thrills resulting from physical activity satisfy the increased need for stimulation) (Rowland, 1990); and
- the boredom theory (sport provides an alternative to occupy a time void, and by participating in physical activities, the child is too tired and too occupied to have energy left for delinquent behaviour) (Rowland, 1990).

The evaluation of the experimental group gives a replication of the above mentioned theories. The contingency Table 4.20.1b and Table 4.20.2b are as follows:

Table 4.20.1: Cross tabulation

			Life Skills – Personal Development T3		Total
			Achieved	Very good	
Life Skills – Personal Development T1	Achieved	Count	22	7	29
		% within LSPD_T3	75.9%	53.8%	69.0%
		% of Total	52.4%	16.7%	69.0%
	Very good	Count	7	6	13
		% within LSPD_T3	24.1%	46.2%	31.0%
		% of Total	16.7%	14.3%	31.0%
Total		Count	29	13	42
		% within LSPD_T3	100.0%	100.0%	100.0%
		% of Total	69.0%	31.0%	100.0%

a. Group = Experimental

P – value = 0.209

Table 4.20.2: Chi-Square Tests

	Value	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
McNemar Test		1.000[b]	.605[b]	.209[b]
N of Valid Cases	42			

a. Group = Experimental

b. Binomial distribution used.

Since 0.209 > 0.05, we can reject H_0 and conclude that for the experimental group there was a significant shift in the ratings for LS – PD between T1 and T3.

Out of the 42 learners, the rating of 7 learners showed an improvement and that of 7 learners showed a decline. In terms of percentages 16.66% of the learners obtained improved ratings in T3, 16.67% attained lower ratings in T3, while the ratings of 66.67% stayed the same. With such a small difference in improved and non-improved ratings, the conclusion can be made that the majority of learners' personal development has stayed on a satisfied level (ratings stated as "stayed the same").

Participation in physical activities will have a beneficial effect on personal development, as proven above. The research studies below supports this conclusion as it found similar results.

During a research study it was observed that 30 min of movement training for 10 weeks reduced anxiety in healthy four-year-olds (Brown, 1982). Psychological testing and teachers' reports were used to monitor participants' responses to activity. Physically fit college students were shown to handle stress better than unfit subjects (Roth & Holmes, 1985). Similar results were found when girls aged 11 to 17 years were studied (Brown & Lawton, 1986).

Psychological function is influenced strongly by blood levels of neurotransmitters such as noradrenaline, serotonin and dopamine. Depression has been associated with a depletion of neurotransmitters such as serotonin. Physical exercise increases the levels of central nervous system neurotransmitters. Studies in older teenagers tend to support the benefits of physical activity in treating adolescent depression (Rape, 1987).

Many researchers have reported the powerful relationship that participation in physical activity has with self-esteem (Gruber, 1986). In most elementary settings, the development of self-esteem is a primary goal because it is considered to be an underlying factor determining student motivation, persistence and academic success (Yawkey,1980).

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The purpose of this research was to determine whether there was a significant difference in academic evaluation reports before and after participation in specific motor learning activities.

Re-statement of research problems:

Whether or not participation in specific motor activities has an effect on specific areas of cognitive functioning in Grade 2 learners.

Sub-problem statement:

Determining the differences in academic evaluation results, before and after partaking in specific psychomotor learning activities.

For this study, intervention research in the context of applied research was the most appropriate type of research. De Vos and Fouche (1998) outline three specific types of intervention research. All three types of intervention research aim to further knowledge in an already identified field of research and at improving intervention as a result.

This research significantly contributes to the learner's well-being as it stresses the importance of physical education. Therefore, it is an instructional priority for all schools and an integral part of our learner's educational experience. High-quality physical education instruction contributes to good health, develops fundamental and advanced motor skills, improves learner's self-confidence, and provides opportunities for increased levels of physical fitness that are associated with high academic achievement.

Mastering fundamental movement skills at an early age establishes a foundation that facilitates further motor skill acquisition and gives learners increased capacity for a lifetime of successful and enjoyable physical activity experiences. Similarly, the patterns of physical activity acquired during childhood and adolescence are likely to be maintained throughout one's life span; providing physical, mental, and social benefits (Newell, 1991). Insofar as physical activity has been associated with increased academic performance, self-concept, mood, and mental health, the promotion of physical activity and exercise may also improve quality of life. Some research suggests that exercise positively affects the hippocampus. The hippocampus is vital for memory and learning. It is important that we expand on these studies in order to establish exactly how exercise affects the brain and it's functioning. Overall, these groups of studies mentioned in the literature review (Chapter 2) are suggesting that an active lifestyle plays an important role in maintaining the function of the brain. If exercise improves mood, it follows naturally that it would improve the thinking process (Fabel *et al*., 2003.)

The discussion of results in Chapter 4 explains that the 1st term evaluation reports were compared to that of the 3rd term, after the learners have participated in a specific motor learning program. A research group consisting of 42 learners was compared to a control group of the same number and the same age. The experimental group has participated in a sixteen (16) week training program, consisting of specific motor learning activities, while the control group had only performed their regular daily activities. Subsequently the participants' academic evaluation reports have been compared in order to note if there are any differences in academic learning areas. The results indicate that participation in motor learning activities has an effect on academic performance, thus solving the research problem.

H_0: Participation in specific motor learning activities for a period of time will not result in an improvement in academic learning areas.

H_1: Participation in specific motor learning activities for a period of time will result in an improvement in academic learning areas.

Thus H_0 can be rejected. Out of the 16 academic learning areas, 9 academic learning areas showed a bigger improvement of the experimental group to that of the control group (56.25%), 5 subject areas showed a decline (31.25%) and 2 subject areas were not affected (12.5%) (no improvement or decline).

Together with this study, a positive relationship of physical activity and academic performance has been explored through several studies conducted in the USA by the California Department of Education (2005); Dwyer *et al*. (1983); Shephard (1997); Linder (1999); Tremblay *et al*. (2000); Dwyer *et al.* (2001) and Linder (2002). These studies support one another, as well as this research, in suggesting that when a substantial amount of school time is dedicated to physical activity, academic performance meets and may even exceed that of students not receiving additional physical activity (Shephard, 1997).

Physical education should be promoted for its many benefits, and fear of negatively affecting academic achievement does not seem to be a legitimate reason for reducing or eliminating programs in physical education. Schools should strive to offer students a balanced academic program that includes opportunities for physical activity. Many questions still need to be clarified on the relationship between academic performance and being physically active. However, to paraphrase Eccles *et al*. (2003), "*We now know enough about the kinds of programs likely to have positive effects on children and adolescents' development*." The literature strongly suggests that the academic achievement, physical fitness and health of our children will not be improved by limiting the time allocated to motor learning instruction, school physical education and sports programmes.

5.2 LIMITATIONS

This study is limited to research into the functioning of specific mental processes (cognitive learning areas) and the acceptance that movement is responsible for the structure of the brain as well as the proven plasticity that, through movement, the brain can be restructured.

Fine motor skills were not majorly included in the motor learning program; the focus was on gross motor skill development and training. Since the empirical inquiry was conducted as part of a dissertation of limited scope, not all of the various factors, which could influence motor learning and academic performance, could be tested.

In conclusion, the results of this study should be interpreted with the following limiting factors in mind. Firstly, the sample size was relatively small which made generalization of the results difficult. Secondly, a factor which was not controlled for this study, the socio - economic status of learners, has been shown to influence the association of physical fitness with academic performance (Cottrell *et al*., 2007) and could therefore have had an influence on the results. Thirdly, several studies found that physical fitness shows stronger associations with some subjects than others (Chomitz *et al*., 2009; Eveland-Seyers *et al*., 2009). More prominent results might have been obtained if additional measures of academic performance in different learning areas or subjects had been used instead of the preselected learning areas. In spite of these limitations, the study offered new and important information that can be used by educators, parents and policy makers in South Africa to advocate and promote physical activity and physical fitness among primary school children.

5.3 POLICY RECOMMENDATIONS

In accordance with international trends (Katzmarzyk *et al*., 2008), studies show that urban South African children are growing increasingly sedentary, unfit and overweight (Kruger *et al*., 2005; Hurter & Pienaar, 2007). Governmental concerns regarding the health of South African school children played a major role in the reinstatement of Physical Education (PE) in the national school curriculum in 2002 (DoE, 2002). Although it is widely recognized that PE provides an important avenue for the promotion of physical activity and physical fitness, recent studies show that PE is regarded as a "*low status*" subject, which is often not offered in schools (Du Toit *et al*., 2007; Van Deventer, 2009).

The investigation of the relationship between physical fitness and academic performance has shed light on the potential role that PE has on learning abilities and academic outcomes of children, and may contribute to a new, positive perception of PE and its implementation in South African schools.

Based on these findings, as well as factors such as national pressure to increase academic achievement in South African schools and the increasing prevalence of obesity and physical inactivity in South African children, advocating the enhancement of physical fitness levels of children by means of maximum educator support and promotion of school PE, is warranted.

5.4 RECOMMENDATIONS FOR FURTHER RESEARCH

Despite the limitations of this study, it nonetheless generated useful information and a motor learning program, which can contribute to clearer understanding of the role of movement in helping a child achieve in his/her academics. Additionally, future research into the mechanisms of the physical fitness/academic performance-relationship in pubertal and adolescent boys and girls, will lead to a better understanding of the potential contribution of PE to academic enhancement among older children.

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APPENDIX A

Motor learning activities

Name of Activity: Agility Ladder Challenge

Purpose of Activity: To help students to practice their foot agility and body control.

Prerequisites: Locomotor movements

Suggested Grade Level: 0-2

Materials Needed: Using floor tape, create six agility ladders around the outside of the tennis courts. Each ladder is about 4m long with 10 rungs. Two ladders are taped to the floor on each sideline and one ladder is taped on each end line. Note: these ladders are made with strips of tape attached to the floor. Create station cards to attach to a cone at each ladder. These cards should include a picture of the activity and a fun name of the skill.

Description of Idea

Divide the class equally depending upon the number of stations you have and assign them a starting station. Moving in a clockwise rotation around the area, have students read the card and perform that skill through the agility ladder. When they have finished the group move to the next ladder, read the card and do the next skill through that particular ladder. Continue around the area until they have finished all stations.

Rules: Wait until the player in front of you is halfway through the ladder before you "*GO."* Do not pass!

Station Cards:

Kangaroo Jump - jump with both feet in each ladder space.

Flamingo Hop - hop on the same foot through the ladder.

Hip Hop - hop on one foot into the first ladder space, hop on the other into the next space - alternate feet.

Slide - facing sideways move leading foot into a space, the second foot follows into the same space then move leading foot into the next space.

Hopscotch - hop on one foot into the first ladder space, in next ladder space land on two feet spread apart (straddle), hop on one foot in the next space. Repeat this hop/jump pattern until you complete the ladder.

Horse - use a gallop - place leading foot in first space, follow with the other foot into the same space.

This idea brings agility ladders to the lowest level by using pictures instead of words. Even non-readers can follow along!

Variations:

This can also be done like circuit training. A squad starts at a ladder and taking turns goes through the ladder using the station card as a guide. When the music stops, the whole group jogs clockwise to the next ladder, reads the card, and begins performing the skill through the ladder. Continue until all groups have performed all skills.

Once they have learned the different ways to move through the agility ladder, it can be an easy warm up. They can choose how they would like to move through the ladder as they jog clockwise around the field.

This activity can also be done using chalk to make the agility ladders.

Assessment Ideas:

A great way to assess jumping and hopping skills. Have one station designated whatever skill you wish to assess and check students off as they come through.

Have students put together repeatable patterns using different movement concepts and locomotor skills or jump patterns.

Teaching Suggestions:

Play some upbeat music for fun!

Have students make up their own patterns and teach each other.

Name of Activity: Balancing Act!

Purpose of Activity: To demonstrate body management skills specific to balance with and without the use of apparatus.

Prerequisites: Prior lessons on body management skills.

Suggested Grade Level: 0-2

Materials Needed: Variety of cones, Pencil for each student, Balancing Act Checklist for each student, 3-4 feathers (or 3-4 plastic bats), 3-4 jumping ropes, balance beam, 3-4 pool noodles, 3-4 beanbags.

Description of Idea

Use cones to designate station areas and prepare each area for activity.

Station 1 Set cones in a square

Station 2 Lay ropes in a line, circle, and square

Station 3 Set cones in a square

Station 4 Lay cones out in a random pattern

Station 5 Set the balance beam low

Station 6 Spread out pool noodles

Station 7 Spread out cones

Station 8 (Beanbags)

Divide students in groups of 3 and assign each to a station. Demonstrate activity at each station before beginning. Provide 2-3 minutes for students to complete balance challenges before signaling them to move on to another station. (Rotate in order)

Balancing Act Checklist

STATION 1:

Balance a feather on your:

___________ palm

___________ fingertip

___________ nose

STATION 2:

Walk the tightrope without falling off!

___________ line

___________ circle

___________ square

STATION 3

Count to ten and balance on your:

___________ right foot

___________ left foot

___________ toes

___________ knees

___________ seat

STATION 4

Move from spot to spot without stepping off!

____

STATION 5

Move from one end of the balance bean to the other and:

___________ walk

___________ side step

___________ Tiptoe

___________ backwards

___________ crawl

STATION 6

Perform the following noodle challenges:

__________ walk from one end to the other

__________ tiptoe from one end to the other

__________ balance on the right foot

__________ balance on the left foot

__________ balance the noodle on your head

STATION 7

Count to ten and balance on your:

__________ two hands and two feet with stomach facing the floor

__________ two hands and two feet with stomach facing the sky

__________ one hand and two feet with stomach facing the floor

__________ one hand and two feet with stomach facing the sky

__________ one hand and one foot with stomach facing the floor

__________ one hand and one foot with stomach facing the sky

STATION 8

__________ Place a beanbag on top of your head. How many times can you walk around the outside of the station areas without letting the beanbag fall off your head?

Name of Activity: Crazy Frog's Lily Pad Game

Purpose of Activity: This activity introduces and practices the forward roll.

Prerequisites: One must know how to do a forward roll safely.

Suggested Grade Level: 0-2

Materials Needed: Cones, Open area, music (optional)

Description of Idea

Lead-up Activity: Crazy Frogs

When the start signal is given (or music starts) students begin jumping like frogs in the open space. When the stop signal is given (or the music stops) each student must find a partner and stand back to back in the "*frog*" position (squatting down with their hands on the floor right in front of their feet). When the activity leader calls out "*Crazy Frogs*" each student lifts their gluteus maximus in the air and looks at their partner between their legs (the peak-a-boo position). When the start signal (or the music begins again) the frogs jump away until it's time to find a new partner.

Lily Pads: Place the cones around the area in a circle with 3-4m in between each cone. These are the lily pads. On the activity leader's signal the students begin jumping counter-clockwise around the area like frogs. When the student arrives at an unoccupied cone, (s)he will perform a forward roll with the following cues: "*frog, peek-a-boo, push*".

Frog: Frog position with hands right in front of your feet (strong arms).

Peek-a-boo: Lift your gluteus maximus in the air and look between your legs behind you. Place your chin on your chest.

Push: Push with your legs and roll on to the upper back to complete a forward roll.

After completing a forward roll the student jumps to the next cone and performs another forward roll.

Variations:

You can have students vary the types of rolls that they are performing and include choices such as the log roll, shoulder roll and even the backward roll after they have had sufficient instruction.

Assessment Ideas:

The activity leader positions her/himself at a cone where (s)he can observe individual students when they arrive at the cone, and, at the same time, observe the class as a whole. By positioning oneself at a central area the activity leader is able to observe and assess every single student.

While assessing look for the cues "*frog, peak-a-boo, and push*." Additionally, look at the body position. Are the students able to roll like a ball?

Depending upon what is taught, the activity leader can observe several different types of rolls and is able to assess them just by telling the students, "When you get to my cone, I would like to see your best forward roll".

Teaching Suggestions:

Beginning rollers may place a beanbag under their chin to ensure that they keep their head in a safe position. Check student health files or with classroom teachers to ensure that no one has any neck stability issues.

Students might get dizzy and become bored with all that jumping so keep this section of your lesson fairly short to help students stay on task and be safe. You might want to vary it with personal stunts and balances.

Name of Activity: Hula Hoop Car Road Trip

Purpose of Activity: Students will use cooperative, respectful and safe behaviours while maintaining good personal space. Students will cognitively recall actions associated with specific "*road terms*." Students will keep their heart rate up through active participation throughout the activity.

Suggested Grade Level: 0-2

Materials Needed: One hula hoop per child

<u>Description of Idea</u>

Each student will hold a hula hoop around her/his waist, keeping the hoop horizontal to the ground throughout the activity. The hula hoop is her/his car and will be used to travel around the gym. (The hula hoop helps each student stay in her/his personal space.) Students need to avoid bumping into the hoops of other children.

While the students are traveling throughout general space, the activity leader will call out "*road terms*." When students hear a "*road term*" they perform the activity assigned to that specific term. Begin with only a few terms. As children learn the associated actions, more terms can be introduced. Some possible terms and their associated actions are as follows:

- Speed Limit 30: Walk
- Bumpy Road: Skip
- Flat Tire: Hop
- Stuck in the Mud: Jog in place
- Interstate: Jog in general space
- Rain: Drop the hula hoop & move arms up & down while making the sound of windshield wipers
- Radio: Drop the hula hoop & turn on the radio -- then sing a tune and dance inside the hoop
- Sunshine: Reach into the glove compartment to pull out cool shades -- put them on using the "John Travolta" fingers in a "V" shape moving over the eyes

- School Crossing: Walk very slowly
- Muddy Road: Slide in the mud by sliding feet & moving hips
- Spinning a Doughnut: Spin hula hoop around waist or other body part
- Out of Gas: Drop hoop & sit pretzel style inside hoop

Assessment Ideas:

Activity leader's observation using a rubric covering: (1) ability to maintain personal space, (2) cooperative, respectful, & safe behaviours, and (3) ability to recall action associated with each term. Increased heart rate can be assessed through students feeling their pulse quickly during and after the activity.

Name of Activity: Name That Level

Purpose of Activity: To reinforce Movement Concepts/Space Awareness/Levels.

Activity cues:

Dribble with hands

- Eyes up;
- Use your finger pads--not your fingertips;
- Keep ball at your side for control;
- Keep ball at waist level or lower; and
- Keep the ball in your "*foot pocket*" which is done by dropping the right foot behind your left foot (right-handers). This will help control the ball and protect it from defenders

Dribble with feet

- Push the ball forward gently with the inside or the outside of the foot. Alternate feet;
- As you travel, keep the ball closer than your fingertips when our arm is extended;
- Use peripheral vision to look at the ball as you look where you are traveling; and
- As you travel, match your speed to your skill. Allow students to self-monitor speed based on their ability to keep the ball close.

Underhand Throw

- Face your target;
- Step with your opposite foot towards the target (i.e., if throwing with right hand, step towards target with your left foot);
- Use a pendulum arm motion with the arm you are throwing with (i.e., like you are bowling); and
- Follow through to the sky with hand you are throwing with.

Suggested Grade Level: 0-2

Materials Needed: 6 pictures for stations, 6 balls (variety), 2 soccer balls and 12 cones, 2 netball balls, 2 beanbags

Description of Idea

Review with students the cues for skills used in stations.

Introduce space awareness and the different levels. Students will move from one station to the next focusing on space awareness, *"levels*." Use a signal to let students know when it is time to move.

Station 1: Roll (low level)

Roll a ball back and forth with friends.

- All students sit in a circle. Use two balls.

Station 2: Throw/Catch with Ball (High Level)

Throw and catch a ball with friends. Try to keep the ball above your head.

- Assign two students as partners.

Station 3: Dribble with Hands (Medium Level)

Dribble a ball with one hand at a time.

- All students dribble in personal space.

Station 4: Dribble with Feet (Low Level)

Dribble a soccer ball with your feet. Zigzag through cones.

- Set up two different courses, 6 cones each (two students for each course).

Station 5: Tap (High Level)

Tap a netball ball with a friend. Try to keep the ball in the air.

- Assign two students as partners.

Station 6: Underhand Throw (Medium Level)

Underhand throw and catch a beanbag with friends.

- Assign two students as partners.

Assessment Ideas:

Informal assessment—Discuss with students while they are at stations whether the activity is at a high, medium, or low level.

Name of Activity: Three Finger Tag

Purpose of Activity: To give children an opportunity to increase their ability to move through general space without bumping into others (or things) or without falling to the ground. It also teaches children how to safely flee from a tagger.

Prerequisites: Students should have had prior lessons on spatial awareness, i.e., how to stay in one's own space and how to move away from others while moving in general space, and also basic dodging and proper tagging (soft tags) skills.

Suggested Grade Level: 0-2

Materials Needed: No special materials needed except for 2 or 3 bibs for taggers.

Description of Idea

First explain and demonstrate as follows: All students start in a self-space with three fingers (points) which they hold up. Select one or two students to be taggers; these students wear bibs. When the "*go*" signal is given, students attempt to keep from being tagged by the taggers while they are moving about the area. If they **fall down**, they lose a point (finger). If they **bump into someone**, they lose a point (finger). If they **get tagged**, they lose a point (finger). If they **lose all three points** (fingers) within the game, they become **helper trees**. Helper trees are **frozen on the spot**, but can still move their arms (branches) to try to help the taggers.

If another student is touched by a helper tree, that student loses a point, so, as the game progresses, the difficulty increases and students must watch for the taggers AND they must also be aware of helper trees.

The students must be honest about when they fall or bump or are tagged and they are responsible for keeping up with this. As the students gain skill and knowledge, the use of strategies can be introduced, i.e., how can a tagger use the helper trees most effectively?

Each game lasts approximately **30 seconds to one minute** at which time select new taggers and all students start again with **three fingers**.

Variations:

Be sure students have had many opportunities to move safely through general space while avoiding others! If not, safety becomes a concern.

For special needs children, have them start with five points, or have them be a helper tree (if they are completely non-mobile.

Assessment Ideas:

Observe each student throughout the different "*games*" to see if they consistently lose "*3 fingers*" or not. This is an easy way to see if students are able to move about the area without bumping into anyone or anything and able to successfully dodge others.

Name of Activity: Match the Roll

Purpose of Activity: To facilitate continued practice of motor and gymnastic skills.

Prerequisites: Students should have been introduced to movement concepts and themes, fundamental motor skills, and tumbling skills (forward, backward, and log).

Suggested Grade Level: 0-2

Materials Needed: 1.open area and cones; 2 hula hoops (six); 3.pictures of various objects that are round and roll like a ball (basketball, soccer ball, baseball, orange, etc.); 4 pictures of various objects that are in the shape of a log (pencil, pen, stick, tree trunk)

<u>Description of Idea</u>

Place the cones and hoops randomly throughout the playing area. Lay multiple pictures (face down) in each of the hoops. Divide students into heterogeneous groups and assign them a team cone.

Game Play

1. Each team begins at their team’s cone.
2. Assign each student 1, 2, or 3.
3. Shout out a motor skill and number (Walking Low, 3).
4. Students travel to any hoop using the motor skill. Emphasize that this is not a race and they should concentrate on performing the motor skill correctly.
5. The student who was assigned the number called out, picks up ONE picture and brings it back to their cone.
6. Each team member takes a turn to replicate the type of roll that corresponds to the picture (for example, if a soccer ball is picked, each student performs a forward roll since the ball is round and circular).
7. Once everyone has completed the roll, repeat the activity, however, with one additional guideline - students can’t revisit the same hoop. They must choose a different hoop to pick a picture each time.

8. Repeat the activity six times (so each team has a chance to go to each of the hoops).

Variations:

Repeat using different motor skills:

- Walk quietly
- Walk heavy and slow
- Walk like a soldier at a parade
- Run lightly
- Run with your hands behind your back
- Run while lifting your knees high
- Hop on your right foot
- Hop on your left foot
- Hop while holding your free foot
- Jump with your arms stiff
- Jump landing with your feet apart
- Jump landing quietly
- Slide with short slides
- Slide at a low level
- Gallop
- Gallop with long steps
- Leap in slow motion
- Leap high
- Skip slowly
- Skip with exaggerated arm action and knee lift
- Skip and clap

Assessment Ideas:

Activity leader informal observation of motor skills. Students help to assess each other's' rolls.

Name of Activity: Balloon Fun

Purpose of Activity: To help students improve their ability to catch and control an object.

Activity cues: Keep your eye on the balloon (ball)

Suggested Grade Level: Gr 0 - 2

Materials Needed: a balloon for each child

<u>Description of Idea:</u>

To get their attention before beginning, begin to toss and catch the balloon in the air. Then tell them we'll be using the balloons today to toss and catch. Ask them what they think they have to do in order to be sure and catch it (hopefully some of them say "*keep your eye on the balloon*"). If they don't know, throw the balloon up and then look somewhere else, therefore dropping the balloon. Then see if they can tell you.

Have them take the balloon to a self-space. Once there, challenge them to do some of the following activities while keeping their eyes on the balloon:

- Toss your balloon up with your (right) hand. Can you catch it with that hand?
- Toss your balloon up with your (other) hand. Can you catch it with that hand?
- Can you toss the balloon up with one hand and catch it in the other?
- Can you toss your balloon up and catch it with either hand for 5 times in a row, without letting it touch the floor?
- How many times can you toss and catch it up without letting it touch the floor? (Let students raise their hand when you say, "Raise your hand if you caught it 1-5 times in a row...5 to 10 times in a row...over 10 times (etc.)".
- Can you toss your balloon up high, run under it, and then catch it?
- Can you toss your balloon up high, spin around, and then catch it before it hits the ground?
- Can you toss your balloon to a partner, who catches it and tosses it back to you?

Name of Activity: Hockey Highway

Purpose of Activity: For students to practice using soft taps to travel and change directions, while dribbling and dodging in general space.

Suggested Grade Level: GR 0-2

Materials Needed: One hockey stick and one ball per student; cones for boundaries

Description of Idea

Striking warm-up stretch:

- hug the hockey stick to the tummy;
- hold the stick with an overhand grip with arms straight out;
- stretch the stick overhead and down to the knees;
- stretch side to side;
- jump over the stick forwards, backwards and side to side;
- balance the stick with the arms and walk around; and
- tap the stick in front, to the left, to the right, and behind.

Let students know they will be working on striking an object with a hockey stick. Demonstrate how they should use "*soft taps*" with both sides of the stick to dribble and control the ball, much like you use "*soft taps*" with the feet when dribbling a soccer ball. Then let them know they will be using these small taps to play a game called "*Hockey Highway".*

Let them know that once they have retrieved their equipment, they are to take them to a self-space and begin to "*start their engines*". This means they are to dribble the object back and forth (left to right) ten times without moving out of their self-space. In other words they pass it back and forth to themselves but don't move. Once they have done this, they can begin to safely travel around the "*highway*" (the open general space), using different pathways (straight, curved, and zigzag) to avoid collisions.

If students lose control of their ball, dribble out of bounds, or have a collision, their car is now "*stalled*" and they have to start their engine (soft tap the ball back and forth to themselves while remaining stationary) again before they can begin to travel again!

As students travel through the general space, remind them to use soft taps in order to keep the ball close to their stick, and to use both sides of the blade.

Variations:

Periodically call out "*red light*", at which students stop the car (their body) but keep the engine going (keep dribbling back and forth). When you say "***green light***", they begin to travel again, as detailed above, keeping sure to change pathways to move away from others. Add cones or other obstacles to the activity space for added challenge.

Name of Activity: Soccer Highway

Purpose of Activity: For students to practice using soft taps to travel and change directions, while dribbling and dodging in general space.

Suggested Grade Level: GR 0-2

Materials Needed: One soccer ball per student; cones for boundaries

<u>Description of Idea:</u>

Let students know they will be working on foot-eye coordination. Demonstrate how they should use *"soft taps*" with both feet to dribble and control the ball. Then let them know they will be using these small taps to play a game called "*Soccer Highway*".

Let them know that once they have retrieved their equipment, they are to take them to a self-space and begin to "*start their engines*". This means they are to dribble the soccer ball (left or right)ten times without moving out of their self-space. Once they have done this, they can begin to safely travel around the "*highway*" (the open general space), using different pathways (straight, curved, and zigzag) to avoid collisions.

If students lose control of their ball, dribble out of bounds, or have a collision, their car is now "stalled" and they have to start their engine (soft taps while remaining stationary) again before they can begin to travel again!. As students travel through the general space, remind them to use soft taps in order to keep the ball close to their feet, and to use both feet.

Variations:

Periodically call out "*red light*", at which students stop the car (their body) but keep the engine going (soft taps while remaining stationary). When you say "*green light",* they begin to travel again, as detailed above, keeping sure to change pathways to move away from others. Add cones or other obstacles to the activity space for added challenge.

Name of Activity: Bean Bag Shuffle

Purpose of Activity: To have students practice and learn their locomotor skills.

Prerequisites: Introduce and practice locomotor skills (skipping, galloping, etc.).

Suggested Grade Level: 0-2

Materials Needed: a variety of colored bean bags, one for each student

Description of Idea:

Every student starts with a bean bag in their hand (Four different colors are good. [i.e. red, blue, green, and yellow]). Each color represents a different locomotor skill (i.e., blue=skip, green=gallop, red=hop, yellow=slide). For a visual cue, make signs that identify the locomotor skill matched with the specific color.

On the activity leader's signal the students will begin their locomotor skill, moving in general space while holding their bean bag. When the activity leader says freeze the students stop and set the bean bag on the ground. The students will then be asked to find a different colored bean bag. The activity leader repeats the directions and the activity begins again.

Assessment Ideas:

Have a rubric with the skills' critical elements at the top and students' names down the side. Watch the students during the activity and check what critical elements they understand and their performance level of each skill performed. Check students numerous times for precision and understanding.

Name of Activity: History Stations

Purpose of Activity: To enhance motor skills while learning about famous sport stars.

Prerequisites: Students should have been introduced to the following motor skills: jumping rope, dribbling, underhand throw, overhand throw, and jumping.

Suggested Grade Level: 0-2

Materials Needed: jump ropes (4), cones (10), balls (8), soccer balls (4), mini hurdles (10)

<u>Description of Idea:</u>

Divide students into groups and assign each group to a station. Introduce the famous sport stars and explain the activity for each station. Rotate students every 2-3 minutes.

1) OTIS BOYKINS -- HEART RATE — Otis invented the Pacemaker.
   - ➢ Discuss heart rate and demonstrate where students can find their heart rate using the carotid artery. Ask student to feel for their heart rate before and after jumping rope. Was it faster?

2) MICHAEL JORDAN -- DRIBBLE - Michael won six championships for the Chicago Bulls Basketball Team.
   - ➢ Dribble around 10 cones while keeping control.

3) JACKIE ROBINSON -- UNDERHAND THROW - Jackie was the first American to play in the Major League Baseball organization.
   - ➢ Practice throwing a fleece ball underhand with a partner.

4) JAMES DULTON-- OVERHAND THROW - James represented South Africa in the 1995 rugby world cup.
   - ➢ Practice throwing a ball overhand with a partner.

5) LJ VAN ZYL -- HURDLE - LJ is South Africa's record holder in the 400m hurdles.

- Jump over a set of mini hurdles.

6) KHOTSO MOKOENA-- LONG JUMP - Khotso won a gold medal for the long jump in the World Championships.

- Challenge yourself to jump farther each jump.

Assessment Ideas:

Checklists noting students who demonstrate proper form for motor skills at each station.

Name of Activity: Locomotor Tic-Tac-Toe

Purpose of Activity: To reinforce Locomotor Skills.

Activity cues:

Hop

- Hopping is very similar to jumping but it is done on ONE foot only;
- Push off with toes and bend your knee to lift off into the air;
- Land softly on your toes and bend your knee and hips when landing;
- Other leg is usually bent with foot held behind you;
- Put arms out to the side to keep balance;
- Hopping can be done in the same place or you can move throughout an area;
- Jump;
- Bend knees and hips;
- Swing arms hard;
- Push off the ground with the balls of feet;
- Gallop;
- Face and move in a forward direction;
- Choose a foot to start with and step forward with it;
- Keep that same leg in the lead during the gallop;
- The back leg chases the front leg but does not go ahead of it;
- Bend at the knees and try to be "light" on your feet as you gallop;
- Slide;
- Face and move in a sideways direction;
- Choose a foot to start with and step sideways with it;
- Keep that same leg in the lead during the slide ;
- The back leg chases the starting leg but does not go ahead of it;
- Bend at the knees and try to be "light" on your feet as you slide;
- Leap;
- Take-off from one foot and land on the opposite foot;
- Extend arms, legs, and toes while in the air;
- Try to leap a long ways as that forces the body to extend;
- Bend knee and hip for cushioned landing ;
- Skip;

- Take a step forward on one foot and then perform a hop on same foot;
- Step forward on other foot, perform a hop (like you did on first foot);
- Keep alternating feet doing this same procedure;
- Arms are out to the side for balance; and
- A skip has an uneven rhythm.

Prerequisites: Students should have been introduced and practiced moving in General Space safely and Fundamental Locomotor Skills.

Suggested Grade Level: 0-2

Materials Needed: 10-12 Locomotor Skill Tic-Tac-Toe game board laminated with heavier film, 10-12 overhead markers, and damp washcloths, Worksheet

<u>Description of Idea</u>

Review moving in general space safely and the locomotor skills (use cues) that are pictured on the Tic-Tac-Toe game board.

Place the Tic-Tac-Toe game board in a specific area, preferably off the floor. Assign partners *and have them write their first name on one of the game boards. Assign one partner "*X" and one "*O". "X*" places an *"X"* in any square on the Tic-Tac-Toe game board using the overhead marker. Partners look and read the locomotor skill marked. On a signal, both partners perform that skill in general space until they hear another signal (15 seconds for younger students, 30 seconds for older students). For example, if "*X*" marks galloping, both gallop in general space. They then return to their Tic-Tac-Toe game board. "*O*" takes their turn. When a player marks three in a row horizontally or vertically, they get to choose any of the locomotor skills on the board for both partners to perform.

Once a game is complete, change partners, wipe the boards clean, have students write their names on the game board, and play again.

Assessment Ideas:

Checklist with names and locomotor skills. Mark locomotor skills of those students who need additional instruction.

Name of Activity: Fire Chief

Purpose of Activity: To demonstrate competency in locomotor skills needed to perform a variety of physical activities while moving safely in general space.

Activity cues: 1. Keep your eyes up. 2. Slow down or speed up to avoid "*crashing*."

Prerequisites: Students should have practiced and be familiar with "cues" for moving safely in general space. Students should have prior practice performing locomotor movements.

Suggested Grade Level: 0-2

Materials Needed: One hoop for every one-two children (different colors to represent numerous fire stations). Optional: fireman's hat or red jersey and bull horn (megaphone) with siren.

<u>Description of Idea:</u>

Scatter the hoops around the open area. Assign *"firefighters*" to a fire station (no more than two per hoop). The "*Fire Chief"* (activity leader wearing a fireperson's hat or red jersey) announces (using the bullhorn) "*FIRE, FIRE."* Students listen to the Fire Chief's command: *"I see firefighters walking safely to put out the fire*." Students demonstrate walking safely in general space using the "cues." As they are walking, the "*Fire Chief*" announces (using the bull horn) the two activity cues. When the fire siren sounds, firefighters must travel safely back to a fire station using the same locomotor skill. Students wait for the next command. Continue playing until all locomotor skills have been performed (walk, run, hop, jump, gallop, slide, leap, and skip).

Assessment Ideas:

Use a checklist of the eight locomotor movements.

Teaching Suggestions:

Have students demonstrate locomotor skills and ask peers to state the locomotor movement.

APPENDIX B

Consent forms

July 2012

Universiteit van Pretoria

Pretoria 0002 Republiek van Suid Afrika

Http://www.up.ac.za

FACULTY OF HUMANITIES
Dept Biokinetics, Sport & Leisure Sciences
Tel: 012-420-6040 Fax: 012-420-6099
www.bsl.up.ac.za

Researcher Contact details:

Cherese Jones

69 Lion Street

Monument Park

Pretoria

0181

Tel (w): 012 804 9095 (St.Paulus Pre – Primary and Primary School)

Cell phone : 076 7574311

Fax: 086 6502493(fax)

E-mail: cherese.jones@gmail.com

APPENDIX B: CONSENT FORM – Learner

Dear Learner

I am studying this year at the University of Pretoria. I am doing a project on how physical activities influence academic results. The name of the project is, *To evaluate the* *effectiveness of participation in specific motor learning activities, on the academic learning areas of Grade 2 learners.* Some children might not be doing enough daily exercises which can influence there learning. This project will help me and your teacher to understand physical activities and certain learning areas a little bit better.

Children, if you want to help me do this project, you will be asked to do specific activities during P.E periods at school, for example skipping and crawling. If you do not want to do the exercises it is fine. If you do not want to do the exercises anymore after you have started, you are welcome to stop exercising. However, I would really appreciate it if you do help me.

There is a variety of exercises that you will do during P.E periods for the whole of the 2nd Term. You need to wear your P.E (exercise) clothes and running shoes or bare foot for the exercises. All information will be kept **private,** meaning that only people like myself, your teacher, your parents and the school will know how you have performed.

Thank you very much for listening. If you want to participate in my project please let your parents help you fill in the tear off slip at the bottom of this letter. Do you want to ask me anything about what I just told you?

Thank you.

I, ____ (full name of child), would like to **OR** prefer not to participate in physical exercises as part of a study on how physical activity influence academic results. *Please underline the preferred choice.*

I therefore declare that I willingly cooperate in these exercises at my own risk. I am aware that I participate voluntarily, and may withdraw from this project at any time if I so wish.

Signature of learner

Signature of witness

Signature of researcher

Date

APPENDIX B: CONSENT FORM - Parent

July 2012

Universiteit van Pretoria

Pretoria 0002 Republiek van Suid Afrika
Http://www.up.ac.za

FAKULTEIT GEESTESWETENSKAPPE
Dept Biokinetika, Sport- en Vryetydwetenskappe
Tel: 012-420-6040 Faks: 012-420-6099
www.bsl.up.ac.za

Researcher Contact details:
Cherese Jones
69 Lion Street
Monument Park
Pretoria
0181
Tel (w): 012 804 9095 (St.Paulus Pre – Primary and Primary School)
Cell phone : 076 7574311
Fax: 086 6502493(fax)
E-mail: cherese.jones@gmail.com

APPENDIX B: CONSENT FORM - Parent

Dear Parent

Currently I am an enrolled student at The University of Pretoria for the MA (HMS) degree. I am conducting a study on *“To evaluate the effectiveness of participation in specific motor learning activities, on the academic learning areas of Grade 2 learners”.* The purpose of the research will allow for an assessment of the effect of specific motor learning activities on academic learning areas after participation in specific physical activities.

My child's participation will involve participation in a variation of specific motor learning activities for a period of 16 weeks during physical education lessons. A determination of improved academic learning results will take place by comparing the 1st term academic evaluation report to that of the 3rd term.

Please understand that your participation is voluntary and that you are not being forced to take part in this study. The choice of whether to participate or not, is yours alone. However, I would really appreciate it if you do share your thoughts with me. If you choose not to take part, you will not be affected in any way whatsoever. If you agree to participate, you may withdraw from participation in the study at any time, without negative consequences.

All information will be treated as confidential; your anonymity will be assured; and your data will be destroyed should you withdraw from the project. Only the University of Pretoria, the student and the promoter will have access to the research data.

Once the final report of this study is completed recommendations will be made to the relevant authorities and organisations.

I, ____ (full name of subject), have read the abovementioned description, and have been informed of the procedures, requirements, benefits and risks of participating in this research project.

I therefore declare that I willingly cooperate in this project at my own risk, and will not withhold any information that may be of importance to the researchers. I am aware that I participate voluntarily, and may withdraw from this project at any time if I so wish, without any cost to myself.

I hereby also grant the researchers permission that my results may be used for publication and/or presentation purposes, with my anonymity being ensured.

Signature of parent	Signature of witness
Signature of researcher	Date

APPENDIX C

Permission letter

APPENDIX D

Results (CD)