The effect of a scissor skills program on bilateral fine motor skills in preschool children in South Africa including skill improvement, equivalence, transferability of skills and skill retention

Ingrid Ratcliffe

A Dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the Degree of Doctor of Philosophy.

Johannesburg, November 2009

Ethics Clearance Certificate Number : M090678

DECLARATION

I, Ingrid Ratcliffe, declare that this thesis is my own work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

____

Ingrid Ratcliffe

___________________, ____ day of________________200__.

PUBLICATION AND PRESENTATIONS

Presentations:

1. Development of a graded scissor skills program for Grade 0 children in South Africa
   Presented at the Wits University Research Day, August 2005

2. Development of a Task Based Performance Assessment for Grade 0 children in South Africa
   Presented at the Wits University Research Day, August 2007

3. The effect of a scissor skills program in preschool children in South Africa, including skill improvement, skill retention and equivalence.
   Presented at the Wits University Research Day, August 2008

Publications:

1. Development of a Scissor Skills Program for Grade 0 Children in South Africa
   Submitted to the South African Journal of Occupational Therapists

2. Development of a Task-Based Bilateral Fine Motor Skill Assessment for Grade 0 Children in SA
   Submitted to the South African Journal of Occupational Therapists

3. The effect of a scissor skills program in preschool children in South Africa
   Submitted to Developmental Medicine & Child Neurology

ABSTRACT

The purpose of this study was to assess the improvement of scissor skills after a graded scissor skills program in preschool children in South Africa (SA).

A bilateral fine motor skills assessment tool was developed for use in this research. This task-based assessment included every day activities required at school as well as personal management items. This research phase included the development of the test items and test instructions, scoring as well as validity and reliability testing of the assessment.

A suitable scissor skills program was then developed for Grade 0 children in South Africa. The program was validated by a pilot study and also by a focus group of occupational therapists. Some changes were made to the picture selection, the grading of the program, as well as to teacher instructions on how to present the program before it was finalised and ready for use in the implementation phase of the research study.

The implementation phase of the study included the individual assessment of 149 learners (mean age of 5 years 6 months), from three different schools in South Africa. The main aim was to establish the effectiveness of the scissor skills program by measuring skill improvement, transferability of skills and skill retention. A further aim was to compare the difference of skill levels of learners from various socio-economic backgrounds in South Africa.

The results showed statistically significant improvement in scissor skills in all groups from the three different schools, as well as an ability to retain the learnt skills. Participants from lower socio-economic backgrounds demonstrated the least skill initially but made the greatest gains during the program, at times decreasing the gap between themselves and other participants.
It was concluded that children benefited from a graded scissor skills program, which allowed them to improve and retain their scissor skills but improvement did not transfer to other fine motor tasks.

ACKNOWLEDGEMENTS

The following persons and organizations are acknowledged with appreciation for their respective contributions to the execution of and reporting on this research project:

- My supervisors D Franzsen (MSc OT) and Dr F Bischof (MSc PT PhD) for their guidance and assistance.
- Professor P J Becker (MSc (UP) PhD (UNISA)) for his assistance with statistical analysis of the data.
- The principals of the two primary schools for allowing me to do the pilot studies at their schools.
- The Faculty Research Committee Individual Grant (University of the Witwatersrand) assisted in purchasing the materials necessary for developing the intervention program.
- The principals of the three primary schools for allowing me to conduct my research at their schools.
- The six teachers, for carrying out the intervention programs in their classrooms.
- Parents, for giving consent for their children to participate.
- All children, for enthusiastically participating in this research project.
- Nicole Sterling for the graphic presentation.
- The postgraduate research group, especially Dr R Crouch for her support and for creating the opportunity of joining a writing retreat.
- Paula, Hellen and Nonceba for spending many hours and weekends with me and helping with the writing process.
- My family for being there for me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOMENCLATURE

1. Occupational Therapy: "The prescription of occupations, interactions and environmental adaptations to enable the individual to regain, develop or retain the occupational skills and roles required to maintain personal well-being and to achieve meaningful personal goals and relationships appropriate to the relevant social and cultural setting" (1 pg 18)

2. Fine motor skills: These are patterns that normally rely on both tactile-proprioceptive and visual information for accuracy. However, fine motor skills may be accomplished without visual feedback if somatosensory functions provide adequate information. The patterns include basic reach, grasp, carry, release, and the more complex skills of in-hand manipulation and bilateral hand use. (2)

3. Bilateral fine motor skills: The use of both hands to accomplish an activity. (2)

4. Asymmetrical bilateral tasks: These are tasks which are done with the dominant hand leading and the non-dominant hand stabilizing. (3)

5. Asymmetrical differentiated bilateral tasks: These are tasks which are done with the dominant hand leading and the non-dominant hand performing a different action. (3, 4)

6. Scissor skills: These include not only the end-product of accuracy, but also scissor grip, cutting motion, cutting approach and cutting time. (5) Scissor skills are viewed as one of the functional activities which require the development of skill and the use of fine motor co-ordination and control that is being consolidated at age five to six years. (6)

7. Critical period: This represents a window of opportunity during which the child is maximally sensitive and also responsive to certain input. It

is during this time that the neural pathway, area of the brain and also skill develops as it should. (7)

8. Skill Retention: This includes the ability of individuals to retain what they have learnt, through practice. (8)

9. Skill Development: Through practice, individuals are able to learn new tasks. The more the individual practices, the more s/he can develop and improve the skill, within genetic limitations. (9)

10. Maturation: Maturation is the term applied to those developments that are pre-programmed and occur in a predictable sequence. (10)

11. Equivalence: *"Equal in value. Having the same result."* (11 pg 310)

12. Task based performance assessment: The use of everyday occupational performance activities in a test, would allow the occupational therapist to analyze each step the tasks involve and then evaluate outcomes in relation to familiar personal management, recreational or vocational school-related activities. (12)

13. Task components: Through task analysis, the therapist is able to establish components of an activity, which are done in order to complete a task or activity. (13)

14. Graded program: This is the adaptation of a program, in order to match the child's capabilities; grading amongst various aspects, includes increasing the difficulty from simple to complex or decreasing the amount of time to complete a task. (13)

LIST OF ABBREVIATIONS

BO:	Bruininsk Oseretsky Test
SASSP:	South African Scissor Skills Program
TBA:	Task Based Assessment
ECD:	Early Childhood Development
OT:	Occupational Therapy
SI:	Sensory Integration
NDT:	Neurodevelopmental Techniques
ADL:	Activities of Daily Living
CI:	Confidence Interval
School 1A:	Group A, School 1
School 1B:	Group B, School 1
School 2A:	Group A, School 2
School 2B:	Group B, School 2
School 3A:	Group A, School 3
School 3B:	Group B, School 3

1. INTRODUCTION – CHAPTER 1

Research has shown that the first years of life are very important as the foundation is laid for future development. In our varied society, children are exposed to very different sets of experiences, directly affecting their progress. This progress is often only measured once children enter school in Grade 1; and this is when the marked gaps in development become clear. (14)
This study focuses on the development of bilateral hand skills, specifically cutting skills.

Bilateral fine motor skills are graded in terms of demands placed on the hands with simultaneous or symmetrical action with both hands like clapping, developing before reciprocal or asymmetrical action of the two hands required by more complex tasks like tying shoe laces and writing. (4)
The consolidation of differentiated asymmetrical motor skills is seen at the Grade 0 to Grade 1 phase (5-6 year olds), allowing the child to develop unilateral use of the preferred or dominant hand in manipulative skills, whilst using the non-dominant hand in a different supporting action. (4)

Therefore before starting Grade 1, as part of their school readiness a child needs to practice a number of asymmetrical bilateral tasks which include scissor skills and activities such as lacing cards, folding paper and stringing beads in order to develop fine motor control and manipulation in the hands. (15, 16) These fine motor skills are a precursor to writing and need to be consolidated before a child can be expected to produce neat, legible writing at school. (15, 17)
The increase in strength and motor skill in the children's hands and fingers as a result of this practice helps to prevent an inappropriate pencil grasp, which is becoming more commonplace when young children are engaged in writing experiences before their hands are ready. (15)

This study evaluated one specific task, namely scissor skills. The internal performance component that supports this skill is bilateral fine motor development. Cutting with scissors, a differentiated asymmetrical bilateral skill requires the child to be able to use both hands together in a skilled way, with each hand performing a different action, yet complementing one another in order to achieve a common goal. (16) This is described as a complex bilateral skill. (18, 19) Scissor skills should really be integrated before the child is able to start in Grade 1.

This is because the adjusting of the dominant hand to demonstrate accuracy in cutting lines in vertical, horizontal, diagonal and circular planes is a pre-requisite to using these movements when writing. When scissors are held correctly, well into the hand, cutting activities exercise the same muscles that are used to manipulate a pencil in a mature tripod grasp. (4) These pre-writing skills develop as a precursor to writing and thus indicate the child's readiness for writing activities. They provide a sequence of pre-requisites necessary for a child to achieve before beginning formal writing instruction. (15)

Scissor skills are also essential in day-to-day school activities. From nursery school onwards, the child is expected to cut out, initially shapes or pictures for arts and crafts activities and later worksheets that need to be pasted into books or used as part of projects. (20) If a simple task requiring scissor skills presents as a difficulty, it slows the child down and the end product may compare poorly to that of the peers.

Competence in using scissors, allowing cutting tasks to be correctly and efficiently completed within time limits, builds up self-esteem and confidence in children and has a positive effect on their general participation in school. (4)

1.1 Statement of the Problem

1.1.1 The Assessment of Scissor Skills

1.1.1.1 Lack of Specific Scissor Skills Assessments

Teachers and therapists constantly use norms to evaluate children's abilities in all areas of functioning. These include gross motor skills, fine motor skills, perceptual skills, language development and emotional development. This is done at all age levels, including at a preschool or Grade 0 level. One of the aspects looked at in the evaluation of school readiness is the child's fine motor skills, including pre-printing, pencil grasp and scissor skills. (15) Norms are thus important in order to understand which children are coping appropriately with the tasks, and which are struggling. (21, 22)

Educators are aware of the correct pencil grip and are thus able to comment on correct or incorrect grips. Further, they are also aware of the correct grip to be used when cutting. Exact norms, however, relating to scissor skills have not been researched or described and thus this area which is widely commented on, has in fact, not clearly been defined and 'norms' have been set, without real evidence of what to expect. (20)

As cutting is a learnt task, any evaluation must be able to distinguish between children who due to lack of opportunities need a stimulation program to improve their scissor skills and those who have genuine difficulties in their development as a result of low muscle tone or poor motor planning that require therapeutic intervention.

1.1.1.2 Lack of Task based Assessment in Occupational Therapy

Many standardised assessments which are used by therapists are not task-based. These assessments (21, 22) do therefore not give an indication of the expected performance according to age for bilateral fine motor tasks (like cutting out a picture) that the child is required to complete during everyday classroom activities. They therefore provide an incomplete evaluation because they do not assess task performance or identify functional problems in terms of everyday activities. These should be the outcome measure by which the child is judged in terms of an acceptable level of performance in the classroom. Assessments therefore need to be developed to provide valid, reliable, and clinically useful evaluation for measuring task performance in typical everyday activities. (23) This complements the general move in occupational therapy to assess the interaction of the client, the environment and the task performance as well as motor components, in order to better establish the appropriate remediation for poor performance, and what steps need to be taken to address the problem. This also brings occupational therapy assessment into line with the activities and participation domains of the WHO's Internal Classification of Functioning (24) which consider limitations and restrictions in terms of the effect of the environment as well as possible deficit in body structure and function.

Socio-economic discrepancies are prevalent in South Africa. Further, schools are still divided, catering separately for children from differing backgrounds. Thus, there has been little change in terms of education since democracy, with opportunities for underprivileged children still being limited. (25) It is the researchers opinion that exposure to good education and thus ability to learn is equated with financial status. Equivalence in terms of skill levels has not been achieved across the education sector. (26)

In South Africa there is a population of children who are being admitted to Grade 1 with little or no practice in the use of scissors which could affect their bilateral fine motor skills, writing and ability to perform required cutting tasks in the classroom. (16) An analysis of scissor skills in a 4 to 6 year old South African urban population found that their skill development varied within the group. Cutting with scissors is not an inherent ability but a skill which is acquired and mastered by practice. (5) This may have long term implications as indicated in a study by Verdonck and Henneberg (27) who found that the manual dexterity of South African subjects (6-17 years) differed depending on socio-economic status. Children from middle class urban areas performed significantly better than those from the poor rural area - the children least likely to have been exposed to tools like scissors and been allowed to develop fine motor skills at an appropriate early age.

1.2 Significance of the Study

This study evaluated the functional ability of Grade 0 children, looking specifically at scissor skills. Children participated in a specifically targeted and graded scissor skills program and their performance was monitored by a task based assessment. An attempt was made to close the gap between children from varying socio-economic statuses, in an effort to place them on a similar point of development at a specific age. Further, aspects such as skill retention, transferability of fine motor skills, the effect of presenting the program at different times in the year as well as normal development during a period of no intervention were assessed.

To increase the level of functioning of children in Grade 0 in South Africa, would be beneficial, not only to the individual but also to the population in general. (26)
This is difficult in South Africa where teachers are faced with the many demands being placed on them, exacerbated by working parents that do not have much time to spend with their children. Cutting with scissors is one of the activities that South African children are often not exposed to at home and teachers therefore need to develop cutting skills in class to improve fine motor skills in children at a pre school level. (17) Cutting with a pair of scissors is one of the skills the teachers need to consolidate in Grade 0 (17) and the possibility exists that a graded program, integrated into the classroom routine, may allow these children to overcome any deficit in this skill. (15, 28) This would be preferable in terms of time, cost and the lack of access to individual occupational therapy, while also preventing excessive referrals to occupational therapy for children who may just require more practice to improve their skill in the classroom. A top-down approach where the therapist develops a graded program that works on skill acquisition would be used, where the theories of motor learning like those of Posner (29), where practice allows the child to acquire the skill, can be applied.

If this integrated scissor skills program is effective, it should assist in eliminating or reducing the functional problems as a result of ineffective scissor skills, due to environmental factors and lack of exposure. The consequences this may have later in terms of the child's ability to cope in the classroom would therefore be addressed.

1.3 Purpose of the Study

The purpose of the study was to develop a task based occupational therapy assessment of bilateral fine motor skills with emphasis on scissor skills for Grade 0 children. The development of scissor skills was addressed as this was identified as one of the essential bilateral fine motor skills, which need to be developed as a precursor to writing and for success in the performance of classroom tasks. Cutting with scissors has been identified as one of the most complex bilateral fine motor skills. (3, 20) The transfer of the fine motor skill developed in this task to other tasks requiring bilateral fine motor skills was considered in the study as well. Although the program designed and used in this study included scissor skills only, other bilateral fine motor tasks were assessed to establish whether there was any transfer in terms of fine motor ability.

Once it was confirmed that there was a deficit in scissor skills in Grade 0 children, a graded program to improve scissor skills in the classroom was developed. This is a short program, aiming to improve scissor skills within a short time frame. This study focused on skill development, learning and the possibility of closing the gap between children with varying scissor skills. The study was aimed at the possibility of children who had little or no previous exposure to improve vastly, in order to approximate the skill levels of other children who had previously already started to develop that skill.

Further, skill retention was evaluated; this is an important part of learning, as children benefit when learnt motor skills are retained and can be used again. The purpose of the study was to evaluate whether the length of the program would enable children to learn skills to the extent that they are able to retain them well. The timing of the program within the year was also considered to establish when during Grade 0 the program would be most effective, in the first or second half of the year.

1.4 Aims of the Study

The aims of the study were therefore

1. To develop and evaluate a task based assessment of bilateral fine motor skills for children between the ages of 5-6 years in Grade 0 with emphasis on scissor skills.
2. To develop and evaluate a class based scissor skills program for Grade 0 children in South African schools.

The objectives of the study were:

- To develop and evaluate an assessment battery for South African Grade 0 children, which would assess bilateral fine motor task performance to be used in conjunction with part of a standardised test which assesses fine motor skills.
- To assess Grade 0 children at schools from different socio economic areas.
- To develop a class based graded scissor skills program suitable for Grade 0 South African children
- To facilitate the implementation of the scissor skills program through the class teachers and establish its effectiveness.
- To implement the program at different times during the year to establish whether time of implementation changes the effectiveness as well as controlling for improvement due to natural maturation.
- To establish whether children retain the scissor skills they have learnt by re-evaluating the children at a later stage.
- To establish whether performance in other bilateral fine motor tasks improves after the implementation of the program, even though they were not directly practiced.
- To establish the teacher's perception of the program.

1.5 Null Hypothesis

There will be no difference in the bilateral fine motor skills and scissor skills of Grade 0 children attending schools in different socio-economic areas before and after an intense classroom based scissor skills program.

1.6 Hypothesis

There will be a difference in the bilateral fine motor skills and scissor skills of Grade 0 children attending schools in different socio-economic areas before and after an intense classroom based scissor skills program.

2. LITERATURE REVIEW – CHAPTER 2

2.1 Introduction

This literature review covers normal motor development, specifically bilateral fine motor development in children. Theories of motor learning are considered as well as the role these play in occupational therapy. It further looks at motor learning in the South African context and the ability of children to develop skills in their differing environmental settings.

2.2 Development

This section reviews the literature on theories of development, motor development in the hand, normal maturation and stimulation relating to motor development. The importance here is to understand that motor development follows a specific sequence in the course of normal maturation.

2.2.1 Theories of Motor Development

Developmental theory has evolved since the early theorists who believed that development was based on genetics, the person or the environment. Freud (1856-1939) described development according to psychosexual stages, placing emphasis on the personality. (30) Neuromaturational theorists such as Gesell and McGraw proposed that development takes the path of a specific sequence, which can be equalled to central nervous system maturation. (13) The importance of the environment on development was pointed out by a number of theorists including Erikson (1963, 1968, 1980)(31) and Maslow (1968, 1970, 1971) who proposed a hierarchy of environmental needs linked to self-actualisation. (32) They were followed by Piaget (1971) who emphasised the influence of the environment on cognitive thought (33), and Vygotsky (1978, 1986, 1987, 1993), who studied sociocultural interactions. (34)

More dynamic systems, looking at the interaction between the individual, the environment and the development of skill have since been proposed by theorists such as Mathiowetz & Haugen (1994, 1995) and Thelen (1995). (13) As the name implies, these theories are more dynamic and take into consideration the 'interplay and interdependence' between the environment, the child and function. Although it is believed that the environment has an effect on the child Case-Smith feels that more research is needed to explain this relationship and that one cannot ignore other factors that are believed to influence learning, including motivation, attitude and self-perception. (13)

These theorists have built the foundation of current thinking in occupational therapy with therapists applying these principles from the theories when looking at child development. Therapists are aware of normal development, individual circumstances as well as the influences of the environment on the child. Further, they consider the principles of motor learning. This study considered the development of bilateral hand function and fine motor co-ordination which form the basis of skill development, needed for coping effectively with objects in one's environment.

> "*The development of motor skills is a crucial part of a child's overall development. If this is impaired or parts are missing, the child not only has difficulty in the everyday activities involving motor skills such as self-help skills, recreational activities, classroom practices but also there is a knock-on effect to other areas of the child's development as the overall progress presents an uneven profile."* (35 pg.39)

2.2.2 Motor Development and Motor Control

The motor control literature covers many factors contributing to the acquisition of motor skills. These include maturation versus learning, massing, learning curves, skill retention, potential of learning new skills, accuracy versus velocity and transfer of skills.

Motor development seems to follow a fairly set pattern or sequence. Children in general achieve the so-called motor milestones within their first year of life.

Some milestones such as crawling or walking are easily observable, however, others, such as various hand grasps, are not that obvious to the untrained eye. (25) Maturation is the term applied to those developments that are pre-programmed and occur in a predictable sequence. (10) Louw et al summarise maturation as the genetically determined development of the human body, with subcategories of growth and ageing. Related to maturation is a critical period; where the child is able to learn, due to the biological and maturational stage s/he is at, and if exposed to the correct environmental influence and opportunities learning will be successful. The optimal period is that time, when the child will most successfully be able to develop a specific behaviour, due to the correct timeous interaction of maturity and stimulation. (25)

Cratty in his summary of studies done on motor performance indicates that gross motor skills tend to be more dependent on maturation, whereas fine motor skills are more dependent on the learning experiences. (8)

Tasks that have been over-learned are less likely to be forgotten than tasks that have barely been acquired. (8) Travis (36) found that when learning a fine motor task, rest periods between tasks are not that important. Different schools of thought are represented in the literature on learning schedules, including massing and spacing during learning of the skill. It was agreed on the whole that massing resulted in greater learning due to the fact that each performance reinforces any loss from the previous performance. Breaks between learning sessions can slow down the process of acquiring the skill. (37)
According to McCraw (38), various 'learning' scores can be obtained, depending on how one looks at improvement. Each skill can also be represented by different learning curves. Ehrlich (39) recommends that curves should be constructed by including initial states, rate of learning and maximal end points.

Learning brings about change through practice and aims to bring about permanent change (for consistency). Epstein found that retention is more related to the actual skill achieved, rather than the type of practice used. (37) The retention of learnt skill allows the learning proficiency to be established. According to Freeman and Abernathy, once a skill has been consolidated the learnt skills remains well established compared to recently learnt skills. (40) This indicates the importance of developing skills at an age appropriate level. This finding is supported by Rouse, Brook-Gunn and McLanahan who confirmed that gaps found in high school students are already present when children start school. (28) This means that children who enter school without being school ready (either with social, emotional or academic deficits) carry their problems with them.

Generally when learners are not structured correctly, with the correct grading of the activities in terms of difficulty, it is difficult to enhance the skill and allow for significant learning to take place. (41) They may then not practice the skill correctly which will affect both the accuracy as well as speed of work. Learners left to develop their own 'style' may use incorrect methods rather than immature methods, thus further slowing down the learning process and often inhibiting them from achieving their full potential. (41)

The theory of skill development includes being shown correct patterns of movement. Further, it is detrimental when learning a skill to work too fast, as this compromises accuracy. Consolidation of accuracy and consistency before acceleration and velocity in motor learning is essential. This results in improvement in co-ordinated movements, impacting on efficiency. Practice allows the development of more segment-specific control so that accuracy can be established and a change in movement efficiency is achieved. Less energy is required with a change at a muscular level and attention can then be directed at developing speed. (42)

It is felt that if intertask transfers are to be observed, emphasis should then be on those components that are actually similar. This supports the findings of Cratty who states that positive transfer does occur between tasks but only if they are similar and especially where the same motor response is required. (8, 43)

2.2.3 Hand Function

While there is a general trend in development of hand function, there is some disagreement in the literature as to when some of these milestones are reached. The terminology used for describing the development of the various grasps also fluctuates.

Herbert in his summary of the development of hand function states that at about six months of age, the baby can hold an object at his midline with one hand and finger it with the other hand. (10) The hand develops in terms of grasp (power or precision) and release, as well as manipulation, which involves the position of an object in the hand being changed. At the end of the first year, another milestone is reached, which enables babies to use the pincer grasp (between thumb and index finger) to lift and explore objects. (10) In contrast to this, Weiss and Flatt describe the development of the hand not according to the power or precision grasp but as grasps with or without thumb involvement. (44) All authors agree, however, that development of hand function takes place in terms of various grasps being used and that it takes place within a sequence and also within a certain time frame. In conjunction with the development of grasps, bilateral hand development occurs, as babies use both arms and hands bilaterally, rather than unilaterally. Later, fine motor skills are built onto these initial grasp patterns.

Erhardt describes the development of bilateral fine motor skills with tasks requiring first symmetry, where both hands are moved at the same time for example banging two blocks together, followed by asymmetrical movements, with one hand leading and the other assisting, or one hand leading while the other stabilises, as in opening a bottle. (3) There is some dispute as to when asymmetrical or differentiated bimanual movement develops but it is placed between 10 (45, 46) and 17 to 18 months. (13) Precursors to simultaneous manipulation are developed between 18 and 24 months according to Ramsey and Weber (47), however, only at two to three years according to Connor et al. (37)

At two years of age the child starts with tool use, in conjunction with in-hand manipulation skills. Tool use typically is required for activities of daily living, such as eating. (46)

2.2.4 Fine Motor Skills and Bilateral Hand Use

The development of fine motor skills is dependent on the development of co-ordination and control of the muscles and movements in the hand performing precise movements. (48) Williams (49) and Keogh and Sugden (50) have suggested that functional asymmetry (using the assistive hand together with the lead hand) when acting on objects is the culmination of the development of bilateral motor co-ordination.

However, identifying when this culmination of development has taken place is difficult and varies according to the exposure and previous practice on the task performed. Bilateral motor co-ordination requirements are different for closing buttons, cutting and writing and these levels of bilateral motor co-ordination are achieved at different age levels. The acquisition of these skills is also a process, which can only be attained when sufficient simultaneous manipulation has developed and co-ordination and control of movements has been established. This can stretch over several months or years. (35, 48, 51) Between ages two and seven, children develop the manipulative skills and co-ordination required for activities of daily living (ADL), construction, writing and drawing, as well as other bilateral skills. Theorists point out that children show the most improvement in simple fine-motor control behaviours from four to six years where activities include combing hair, dressing and tying shoes laces. (48, 50) By four years, the child has sufficient co-ordination and control to carry out activities while using many grips, including the tripod pencil grip. (35) The mature stage of bilateral hand use involves complex co-ordinated opposing hand and arm movements with good motor control which Erhardt describes as bilateral differentiated movements which occur when each hand performs differently as in cutting with scissors or playing an instrument. (3) These skills emerge between four and six years (3) and are established as more complex control needed for activities like drawing and writing with a pencil improve from five to 12 years. (48) The development of hand, thumb and finger control and co-ordination, in-hand manipulation skills; arches of the hand; hand dominance; motoric separation of the two sides of the hand (13) and isolated finger, hand and wrist movements are all essential elements in the mature stage of bilateral hand use. (48)

Since the assessment of mature bilateral hand use is inextricably linked to observation of hand use in skilled activities the opportunities the child has had to develop these skills plays a role. Thus the use of the mature bilateral hand functions, in tasks, is dependent on exposure to tasks such as cutting with scissors. As will be discussed later, environmental influences play an important part in this skill development. However, all children (without underlying difficulties) achieve the various basic grasps and inherent bilateral hand functions within a slightly different time frame as part of their normal development.

The development of bilateral hand use also results in functional asymmetry, which leads to the emergence of a preferred hand. The question of when hand preference emerges and is expected is also widely debated. The literature agrees that handedness is observed early yet often this still fluctuates between the right and the left hand in the first year. (52, 53, 54, 55, 56, 57) Ramsey et al in their study in 1979 found that hand preference does not appear before the age of 14 months. (47) This seems to coincide with the frequency of 'bimanual action' which increases at 13 months of age. Fagard and Marks demonstrate that bimanual manipulation encourages hand preference, especially as the child shows some success and then more consistently uses one hand as the passive and the other as the active hand. (45) In 1985 Tan found that children who have not developed a hand preference are generally less skilled than those children who either have right- or left- preference. It is generally accepted that hand preference is established between three and four years of age. (58) Gesell, however, felt that hand dominance does not become well integrated in some normal children until eight or nine years of age. (53)

The performance of any fine motor skill requires more than the development of hand function and the fine motor co-ordination to perform a skill. A variety of other prerequisite abilities have to be in place. Vision is important, as it allows feedback and also refinement of hand movement. Further, kinesthetic input from the muscles, joints, tendons and skin provide information for the development and refinement of fine motor skills. (48) The position and support of the hand during the movement is also important and requires postural control of the trunk; normal muscle tone; shoulder and elbow stability and mobility; forearm rotation, wrist stabilisation and strength. Sensory integration as well as visual perception; visual motor control; spatial analysis and planning all need to be intact for complex fine motor skills to be achieved. (13, 20, 59) Environmental, social and cultural factors also influence the development of motor skills and motor learning. (13) If any of these factors are deficient the development of these fine motor skills involving the use of a tool, will be affected. (43)

2.2.5 Environmental Influences

Although theorists agree on a certain sequence of development there is a discrepancy in the literature as to precisely when children are able to achieve the different bilateral skills. There is agreement about the early stages of development and pre-programmed motor milestones in the form of basic hand function and bilateral manipulation. However, there is disagreement when complex mature bilateral manipulation and skill development in activities like cutting or dressing is established. This poses the question of the influence of environmental factors and opportunities afforded to the child versus normal maturation and development.

Cratty points out that after infancy fine motor abilities are mainly determined through learning. (8) He is supported by various theorists and researchers who explain that maturation provides the initial motor patterns, whereas the refinement of movement is based on learning, resulting in mature movement patterns. (20, 60, 61) In the case of hand function and co-ordination, once the basic milestones have been achieved, the child requires exposure to tasks and activities in order to achieve mature patterns or learn new motor patterns. This means exposure to the correct stimulation to learn and consolidate these abilities. The home environment, social interactions and cultural influences are what affect this stimulation in the pre-school years (early childhood from two to six years). (25, 28) In 1979 Ayres who looked at development from a sensory integrative perspective, backed up this concept. After the first year, in which development was programmed, variability increases and behaviour becomes more complex. (62, 63) By the time children reach school, their skills vary vastly because of differences in environmental opportunities, familial and cultural influences, personal experiences, and genetic endowment. (13, 28, 63) The influence of children's environment will depend to a large extent on their capacity to learn, and the presence of significant people to 'teach' them. (10) Chambers and Sugden argue that between ages two and seven, it is crucial to expose children to a variety of activities in order to improve basic skills including fine motor skills that have been learnt. (35) In a study in 2007, Olson found that high-quality early education can improve school readiness. Further, children who are school ready are less likely to drop out of school or repeat grades. As adults they are more likely to have a job, earn more money and are less likely to be involved in crimes. (28) Thus it is important to consider the theories of motor learning and for this study which will look at the role of bilateral fine motor skills in children about to enter school, specifically the development of scissor skills.

2.3 Motor Learning

Motor milestones, as mentioned previously, are pre-programmed and happen automatically in a fairly specific sequence within a certain time frame. They are not environmentally influenced and form the fundamental motor patterns and can be viewed as the pre-cursors to motor learning. (20, 60, 61) Herbert describes the child's development as a complex interaction between learning and maturation. (10) Learning is usually defined as any enduring change in behaviour that results from instruction or experience. Motor learning is an improvement of performance as a result of practice. (43) The literature intimates that motor learning allows one, through practice, to become skilled at a task. Thus when the term skill is used, it is implied that learning has taken place. (9)

Theories of motor learning underlie much of the paediatric occupational therapy, part of which involves skill development, which is achieved through practice. Using the stages of motor learning, allows an occupational therapist to understand the developmental processes children have to go through in order to learn a task such as cutting with scissors. Most models of motor learning present three stages.

The Fitts and Posner model included (29)

- a cognitive stage, where performance fluctuates greatly and a wide range of errors are made as the motor skill is learnt.
- an associative stage in which the basic skill has been learnt. The skill is now being improved on, decreasing the fluctuation of the response and intensity of errors. As awareness of some of the errors grows, learning to correct them takes place.
- an autonomous stage, where there is no focus on the movement as it happens automatically. Focus is on aspects of the overall movement to improve the quality of this, but generally there is little fluctuation and the skill is consolidated.

Magill subscribes to the similar 3-step model of stages of learning, where changes in performance can be observed; the skilled person is able to perform a task and while performing recognises potential mistakes which are corrected if necessary. Output is judged correctly and through practice accuracy further improves. Performance is more consistent even if there are changes in the environment. (43)

The three stages presented by Piper & Darrah (64) and Gentile (65) in their models for acquiring a new motor skill are essentially similar to those described and include exploration in stage one, improvement of the skill using feedback in stage two and the most efficient way of performing the skill in stage three. This last stage reflects skill achievement in all the models.

The above models form the basis of how the occupational therapist views both the assessment and intervention of skills acquisition, more precisely skills affecting everyday functioning. Principles of treatment allow the occupational therapist to grade the way in which activities are used to improve motor learning. Grading occurs according to the following principles:

- Simple to complex. Simple tasks are followed by a sequenced response whereas complex tasks require the integration of information from a variety of sources. (66)
- Open - loop to closed - loop tasks. Open loop tasks do not allow for correction of movement while performing, whereas closed-loop tasks use feedback from the child and the environment in order to correct the motor response during the activity like cutting with scissors or playing piano. (67)
- Environment stationary to environment changing. It is easier to learn a task that is predictable. If the environment changes as in playing sport the environment has to be monitored and adaptations made. (68)
- Novel to acquired. With practice, the task becomes easier; learning a new motor skill initially requires effort and eventually becomes automatic. (69)
- Task modality. This refers to different learning styles; some learn easier through visual, auditory or tactile experiences. Thus the modality of the task affects learning. (13)

The issue for occupational therapy in terms of motor learning is what the norm according to age and performance is for a specific task. Although this is generally age related the variance in the acquisition of skill plays a role. Therapists also need to know how much practice is required and when the skill is considered acceptable. As occupational therapists view motor learning in functional tasks, transferability of skill components acquired in one task to other activities is also important. This relates to the laying down of components or motor engrams for activities.

Motor engrams were first described by Lashley in 1951 as motor movement, which through learning, becoming stored in the central nervous system. (70) The motor engram is stored through memory and can be accessed when required. Schmidt also maintains that motor engrams are attained by the individual through practice and feedback loops while performing the task, rather than through developmental processes. (71) Paris further developed this theory indicating that motor control is not simply ‘neural maturation’ but is dependent on exposure to and practice of motor skills. (72) Motor engrams and transferability of skill from one task to another is further discussed in detail in Chapter 4.

The development of fine motor skills is dependent on many variables and this study only considered the aspects associated with hand function and fine motor co-ordination. These aspects were observed in the performance of functional tasks to establish what motor learning has taken place in relation to these tasks by the age of five to six years with particular reference to cutting with scissors.

2.4 Scissor Skills

Scissor skills are viewed as one of the functional activities which require the development of skill and the use of fine motor co-ordination and control that is being consolidated at age five to six years. There is little published academic research available in the area of scissor skills, thus limiting the resources presented in this literature review. In a review of the development of scissor skills Levine (6) stated that if children between ages two and three years are exposed to cutting activities they learn to grasp scissors and open and close the whole hand to snip. Since motor development occurs from proximal to distal, the child initially moves the shoulder to control the scissors as the forearm and hand still move as a unit and the child is not yet able to isolate movements distally.

This indicates clearly the need for maturation before the learning of a motor skill can be expected. The isolation of movement needed for adequate scissor skills only develops between the ages of three and four. This is when the child learns to move the wrist independently from the arm which results in more control over the scissors as the child learns to keep them on a line while cutting. The paper can also then be stabilised in one position by the other hand.

From the age of four years there is further isolation of movement allowing the child to use finger and wrist movement to control the motor output and by the age of five to six, most children have developed the prerequisite control for using fine movements. They can stabilise the upper arms, giving them a stable base to work from. Many, however, are still learning to move the arms and hands in an efficient way to control scissor movement and to adjust the orientation of the paper with the non-dominant hand at the same time. (6)

Levine in her research presented the perfected action for scissor skill but did not describe the process of development of the skill or give any norms for the skill at different ages.

When cutting with scissors she recommended that the child should be sitting at a table with both feet on the floor. Scissors should be held in the dominant hand, which is placed in mid position with the wrist in neutral or slightly extended. The thumb is placed through the top loop of the scissor and the middle finger is placed through the bottom loop. The index finger helps to hold the scissor steady. The scissors are held loosely at the PIP joints of the hand. (6, 20, 46) and ring and little fingers are held in the flexed position. This grip is often only achieved at six years, or even later. The non-dominant hand holds the paper with the arm slightly in supination. The cutting action should be smooth and rhythmical and the child should be able to adjust the speed of the hand movement to the snip size. Further, the child should be able to adjust the wrist to the line/curve being cut. The elbow remains next to the trunk while the hand adjusts to the cutting action.
Levine describes undesired responses in undeveloped scissor skills as the child having the dominant elbow up in the air as the arm moves to align the scissors. This also includes the non dominant hand holding the paper without movement and not stabilizing the paper or stabilizing ineffectively. The wrist moving with jerky snipping movement resulting in snips of various sizes and the tearing of the paper due to poor control or because the scissors were moved forward too fast for the size of the snip were also identified.

The Peabody Developmental Motor Scales outline the expectations in terms of cutting with scissors according to an age norm which includes the ability to snip with scissors by two years and cutting across a 15 cm piece of paper by two and a half years. By three to three and a half years children can cut on a line that is 15 cm long and by four years they can cut a circle. From four and a half to five years they should be able to cut a square. (73) Generally literature agrees on the development of initial scissor skills which includes first learning to hold scissors, then starting to snip and finally cutting a straight line. Variation for later skill development in terms of the order of shapes cut, accuracy and speed is reported by Schneck. (20)

Scissor skills are necessary for the functional activity of cutting with scissors and thus the development of this and other fine motor skills is essential before entering school, so that the child is prepared for the classroom requirements they will face. This will assist them in dealing with other scholastic, social and emotional aspects of schooling, allowing future learning to be a positive experience. (74)

2.5 The importance of fine motor skills and scissor skills in the classroom

The Grade 0 year is an important part of a child's development as it is considered the year that a child becomes 'school ready'. This term describes a child's development, not only emotionally and socially, but also physically in terms of their fine and gross motor co-ordination and cognitively in relation to their ability to face the challenges of formal schooling and benefit from them. (25) It is one point on the continuum of learning on which formal schooling will be built once the child enters Grade 1, where they learn to read, write and do mathematics.

There are many school-readiness tests available both in South Africa and on the internet. (25) Included in the test items are independence in aspects of dressing like closing buttons and tying shoelaces and other fine motor skills like holding a pencil, colouring, cutting and writing their name. This emphasises the importance of the development of these skills as a pre-requisite to entering Grade 1.

McHale and Cermak (1992) investigated the time allocated for fine motor tasks in the pre-primary classroom and found that between 30% - 60% of the time is allocated to fine motor activities, of which handwriting is the most predominant task. Other fine motor tasks included cutting with scissors and using a computer keyboard. (75) Landy and Burridge felt that even more time, between 60 – 70%, is spent doing fine motor activities in Grade 1. They go on to say that 12 % of children experience difficulties in this area which leads to social, vocational, academic and psychological or emotional consequences. (48, 74) Thus when a child has not had an opportunity to develop motor learning required for specific fine motor skills like cutting with scissors, other bilateral fine motor skills, which develop later and are reliant on the development of the skill components learnt previously, are affected. If this deficit is not rectified at an appropriate age, the lack of skill will impact to a greater and greater extent on other tasks, activities and motor learning required, as the child gets older. (76) Pre-writing skills are those that prepare the child to be able to hold a pencil and form letters. Thumb, index and middle fingers are known as tripod fingers and carry out skilled movements, whereas ring and little fingers are stabilising fingers, which provide stability and increase the strength of the grasp. (77) The movements used in writing require the same muscle groups as those used in cutting with scissors, thus scissor skills assist with control, co-ordination and strengthening of muscles and movements needed for writing.

Handwriting is one of the most complex fine motor skills and is viewed as a functional activity for the school-aged child in that it is an expected skill necessary for functioning in a mainstream classroom environment. (78) Dysgraphia due to motor clumsiness (the inability to write legibly due to poor pencil grasp and an inability to form letters), can present as a direct result of poor motor control due to inadequate development of fine motor skills and this has become a recognised problem in schools and tertiary education settings. (76)

In South Africa there is a large variation in children's socio-economic backgrounds. These, as mentioned, have an effect on their skill development including cutting. (5) In two studies completed on children in South Africa the importance of early exposure to fine motor activities is emphasised. Verdonck and Henneberg when making recommendations on the problems with dexterity in children from low socio-economic backgrounds felt that children should take part in activity programs, implemented by parents or teachers. (27)

Ratcliffe felt this exposure in terms of the fine motor task of cutting with scissors should occur when the skill is developing and that one could strive to eliminate differences in skill level found in children aged four to six years, irrespective of their background and opportunity. This would enable all children to start off on a similar level in Grade 1, rather than children with inadequate skill having to close the gap and still develop their ability to use tools required for academia. This lack of skill has been related to adverse environmental conditions. (5)

Therefore opportunities need to be provided for children to learn and develop the required skills; so that rather than decreasing the standard, services are improved giving each child the means to progress. (5)

The general trend has been to 'leave the child to develop' as there is a common misconception that children 'grow out of problems'. This is not the case, as it is not a matter of maturation but a matter of the environment providing adequate learning opportunities. More importantly, this learning has an impact on function, and function allows a child to develop a healthy self-esteem, which has an impact on the child's general well being. (74)

Thus when using the occupational therapy frames of reference, therapists working with children with delays in development need to be able to differentiate whether the delay is due to either underlying difficulties or environmental deprivation.

2.6 Conclusion

In conclusion the need for a proper task based assessment and improvement of skills has become apparent. This is to serve all children in that age range where these skills are being developed so that they are learnt at the appropriate time and gaps in skills levels do not exist when children start school in Grade 1. Literature supports the need to give children the opportunity to develop and practice bilateral motor skills so they can achieve a certain point on the continuum at a certain age. This will facilitate further development and allow children to then acquire new age related skills through their school without any developmental delay.

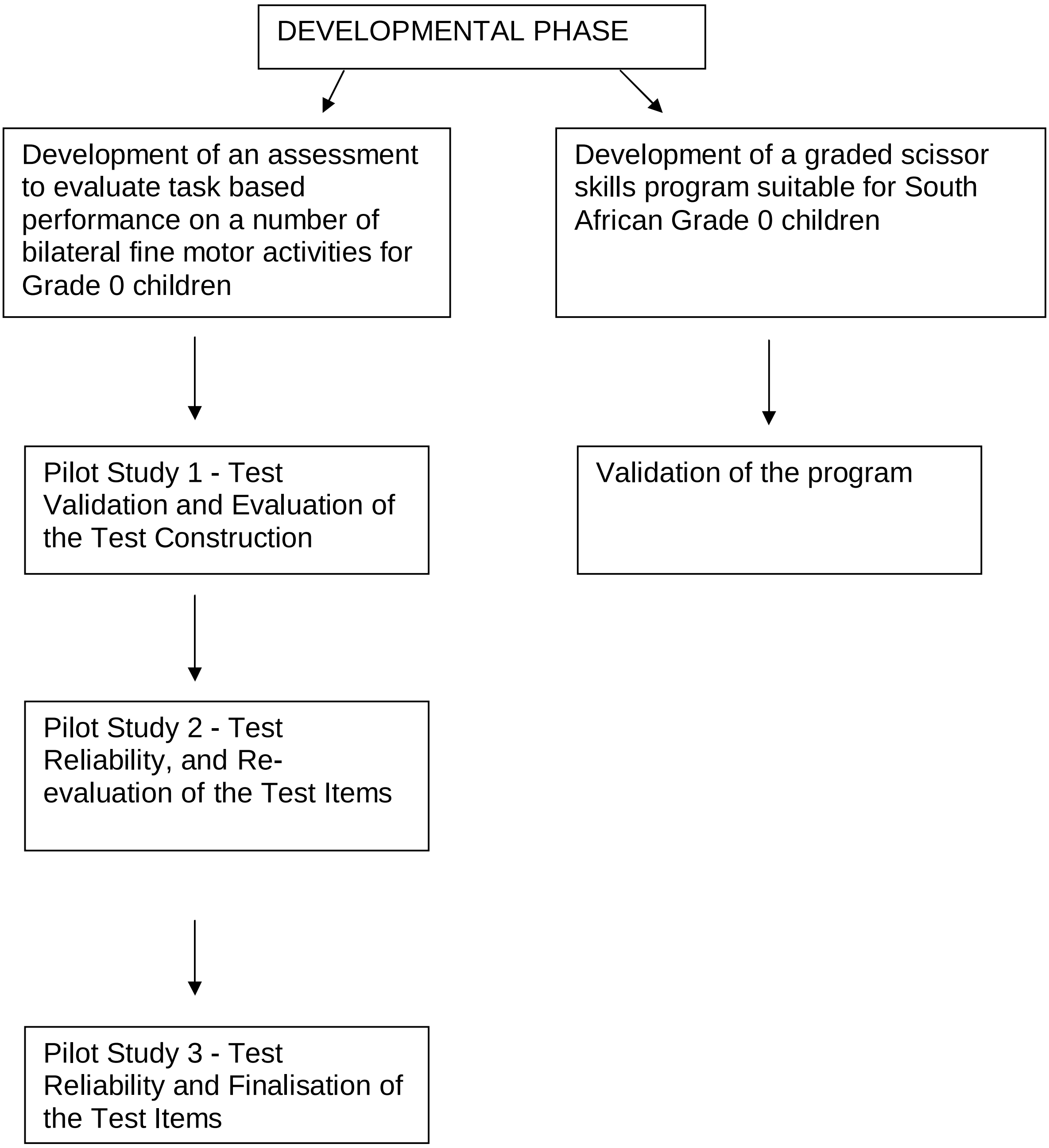
3. DEVELOPMENTAL PHASE – CHAPTER 3

In order to assess scissor skills in Grade 0 children, it was first necessary to develop:

- a task based performance assessment for bilateral fine motor skills
- a graded program for scissor skills for Grade 0 children

These parts of the study were carried out simultaneously as indicated in the flow diagram below.

Figure 3.1 Flow Diagram



3.1 Development of a Task Based Performance Assessment

Occupational Therapists assess children in order to establish an understanding of the child's level of participation in daily activities. (13) With the development of the International Classification of Functioning, Disability and Health (ICF) the importance of incorporating outcomes measured in the domains of activities and participation and the role they play in health has been emphasised. (24, 79)

Many standardised assessments available to occupational therapists in South Africa for the assessment of fine motor skills are paper based and evaluate body function and internal performance components without considering the child's everyday activities in terms of personal management or schoolwork. In both the Developmental Test of Visual Perception (80), and the Movement Assessment Battery for Children (22) the therapist is expected to note 'qualitative observations' like posture and pencil grip during the assessment but these aspects do not affect the scoring of the tasks. The child is scored according to the speed or accuracy only. Both these assessments were developed in the USA and are standardised on American children. Many assessments used in South Africa are standardised either in America or Britain and are not necessarily reflective of our South African population.

In occupational therapy it is essential to record and establish outcomes that include all aspects of a child's functioning in activities so the therapist can provide treatment, which allows the child to succeed in their occupational performance of daily activities and participate successfully in all aspects of their lives. It is important to use every day activities like scissor skills required at school and for personal management with which the child is familiar when assessing, in order to establish what they can achieve and where there is really a problem. (81)

Thus in order to assess fine motor skills in South African children the development of an assessment based on everyday activities was planned. The use of these everyday occupational performance activities in a test, would allow the occupational therapist to analyse each step the tasks involve and then evaluate outcomes in relation to familiar personal management, recreational or vocational school-related activities. (12)

Activities which assess the ability of Grade 0 children to complete bilateral fine motor occupational performance tasks, including the ability to cut with scissors and how this skill compares to the performance outcomes, were therefore identified and considered.

Both quantitative and qualitative observational assessments were incorporated into the judgement of these fine motor skills. In the test development the elements in the tasks were analysed and the motor components required in completing the elements identified. The accuracy or quality as well as the consistency of the task performance in relation to these task elements were considered in the development of the scoring. Efficiency and speed of performance were included by adding a time element.

3.1.1 Development of the Test Items

The following bilateral fine motor tasks were identified as being in the repertoire of 5-6 year old children's everyday occupational performance activities in personal management and schoolwork. Play was not included as this

> "is an activity that is undertaken purely for enjoyment or amusement and has no other objective" (82 pg 1)

and therefore cannot be a structured test item.
Recently occupational therapists have started to look at play as an entity by itself, not just an occupational performance area in which play activities are carried out. It is seen as primary occupation of childhood. (83,84)
However, many occupational therapists see play as having a secondary role, as a means to gain observations and improvements in skills such as motor skills. As play is difficult to assess, requiring many observational skills, it was not included in this task-based assessment. (85)

The personal management activities requiring fine motor skills suitable for children of this age are dressing and eating. Other than being able to button shirts and fasten their clothes, according to the literature, children are also expected to tie their own shoelaces at this stage. (86) This is an important task for school going children who often have to wear lace up shoes, as it promotes independence in dressing. During a school day, children may need to take off their shoes for sport and therefore need to be able to put them on again independently.

In terms of schoolwork, 5-6 year old children are being prepared for Grade 1, i.e. they are becoming school-ready. Teachers that had experience in pre-school as well as grade classes were consulted and asked which fine motor tasks they felt were important and were included in their daily routine in their classes. Activities such as play dough, cutting and colouring were mentioned. They felt that the development of the pencil grip was very important as well as tracing, drawing within lines and free drawings, threading beads, cutting and folding paper. Working with thick triangular pencils and colouring pencils, as well as felt tip pens was also emphasised.

The activities to be included in the assessment also had to be considered in terms of the levels of difficulty related to bilateral hand involvement. Only asymmetrical bilateral tasks were considered. These are tasks which are done with the dominant hand leading and the non-dominant hand stabilizing (asymmetrical) or those, which are done with the dominant hand leading and the non-dominant hand performing a different action (asymmetrical differentiated bilateral tasks). (3) The activities needed to reflect the South African setting, to be suitable for all children living in this country.
Lastly, it was important to include a number of different activities to evaluate the bilateral development of Grade 0 children, as this would yield more sensitive and accurate outcomes in terms of the child's performance.

Suitable activities were selected and analysed in relation to the tasks involved. The components for each task to be included in the test were then identified and the expected execution of each described. (Appendix A). The tasks are as follows:-

Asymmetrical bilateral tasks

- Drawing with a ruler
- Name writing
- Threading beads
- Lacing

Asymmetrical differentiated bilateral tasks

- Folding paper
- Cutting out a square and circle
- Tearing
- Tying shoelaces

3.1.2 Development of Test Instructions

Most standardised tests rely on verbal instructions, which present a problem in a country like South Africa where a number of different languages are spoken. Translating instructions may affect the results of a test and therefore the administration of the test should rely on verbal instructions as little as possible. The items were designed to use an end product and demonstration to guide the child as to what was required with simple two to eight word instructions only, that could more easily be translated if necessary. (Appendix B).

3.1.3 Scoring of test items

3.1.3.1 Identification of task components

Activity analysis is the process used to examine activities and determine which components are used in their execution. Traditionally this is done by observation of others or by the therapist executing the activity. Observations based on biomechanical or neurodevelopmental frames of reference (12) as well as execution of the activity by the researcher, were used to analyse the fine motor components in the chosen bilateral tasks. Criteria for evaluation were then set so that a performance-based outcome could be established for each component.

Both movement (mobility) and stabilisation (stability) (12) were considered in each fine motor component and the following four criteria were identified and utilised when analysing the tasks:

1. accuracy (A) - an evaluation of the end product of the task.
2. motor components (M) - observing how the task is performed, including the positioning of the body and grasp of tools.
3. time (T) – the length of time it takes to complete a task.
4. efficiency of movement (E) – how easily the components of the task are performed, for example are all steps in the task included to make it efficient, like stabilising the paper when writing so it does not move.

This scoring method was used, as tasks were broken down into easily observable components, which could consistently be scored. It therefore does not rely as much on the experience of the therapist in order to assess the children accurately, as would be the case if the assessment relied on observational and analytical skills, which are closely linked to personal experience and knowledge.

After analysing and dividing the tasks into motor components (Appendix C), the eight bilateral tasks that had been selected were finalised as the initial test items.

3.1.3.2 Allocation of scores for each item

A scoring system was developed for the test items so that clinical observation and measurement of the outcomes could be recorded. On consultation with the statistician the scores were allocated according to the correct response, thus the higher the score, the better the performance of the child.

Observation sheets were developed for the eight tasks either using a point system or yes/no answers, so a percentage score could be worked out. Some items were also timed and the score was noted in seconds. Once again special consideration was given to the scoring of cutting with scissors. (Appendix D)

Using the four criteria described above the various components on the observation sheets were allocated points. By performing all aspect of a whole task correctly, a certain amount of points could be scored. Therefore each of the eight test items had a different maximum score, depending on the number of components assessed in that item, for example for tying shoelaces a score of 8 points was possible while for folding paper it was only 5 points. (Appendix D)

Since a variety of tasks used in the test were not equivalent, the scoring needed to reflect the importance of the tasks, in relation to the expected activity performance of a Grade 0 child. Twelve experienced occupational therapists, who had worked in the paediatric field for at least eight years, were asked to weight the assessment items according to their importance for Grade 0 children. The therapists had to weight each item against the other seven items on a 10 cm line. The order of importance of the items in the test was then worked out by using the ratio and logarithm.
The following order of importance of the assessment tasks was established:

- Cutting (most important bilateral task for Grade 0 children);
- Tearing;
- Tying shoelaces;
- Folding paper;
- Name writing;
- Threading beads;
- Lacing;
- Drawing with a ruler.

Scoring was weighted for the items according to their importance.
(Appendix D)

Table 3.1 is an overall summary of the development of the test items. It indicates changes made to the items and the inclusion or exclusion of the items into the test.

Table 3.1 Overall Summary of Test Item Development

Initial Test Items	Pilot Study 1	Pilot Study 2	Pilot Study 3
Drawing with a ruler	No change	3 trials	exclude
Name writing	No change	Margin of error introduced	Scoring adjusted for pencil grip
Threading beads	No change	No change	No change
Lacing	exclude	N/A	N/A
Folding paper	Change scoring	exclude	N/A
Cutting	No change	Use Video	Cutting approach added
Tearing	No change	Introduced Curved Path	No change
Tying shoelaces	No change	No change	No change
-	Drawing around an Object (Added in 2nd assessment)	Change Scoring	No change
-	Buttoning (Added after Pilot 1)	Change Scoring 3 Trials	No change

3.2 Test Validation and Evaluation of the Test Construction

It was important at this stage to validate the test, and to pilot the test items, as this task-based assessment would be used as a base line assessment for all participants at the start of the study and all changes in performance would be measured and compared to this initial assessment. The assessment was only developed for the purposes of this study and it was not an objective of this study to develop a standardised assessment test, to be used by occupational therapists. A future aim is to further develop these assessments into a standardised test to be used by occupational therapists in the clinical field. This would include a larger number of participants as well as statistical analysis such as Rasch analysis.

3.2.1 Content Validity

3.2.1.1 Focus Group with Occupational Therapists

A focus group was planned and prepared. (87) Fourteen experienced occupational therapists that have been working in the paediatric field for at least eight years were asked if they would be able to participate in the focus group. These therapists were all from Gauteng, so that they would be able to attend the meeting. 50% of the therapists had SI (Sensory Integration) training and 20% had NDT (Neurodevelopmental Therapy) training above the basic OT training. Two therapists were unable to join in the focus group, as they had prior arrangements. Twelve therapists were prepared to participate and all of them were able to attend one of the two evenings. Six therapists were present in each focus group. They were asked to judge the assessment for content. Individual items on the assessment were discussed and they were asked to weight the importance of each task against the other bilateral tasks. Further, each therapist was asked to evaluate the scissor skills program in terms of content (suitability of pictures) as well as level of difficulty of the pictures and the practice component. Therapists were asked to comment on grading of the program as well as the picture-practice match.

3.2.1.2 Results of the Focus Group

Content validity establishes that the items on the test represent a range of possible items the test should cover and the traits that it is designed to measure. The experienced occupational therapists felt that all items included were bilateral tasks and also relevant to Grade 0 children. It was suggested, that one further personal management task should be included in the assessment. Initially, eating with a knife and fork was suggested but practically this would be difficult to do as assessments were planned for the classroom setting. There are also various restrictions due to diets that children may have, making it difficult to choose a suitable food for all of them to eat. Therefore, putting on a shirt and closing the buttons was included instead.

The expert occupational therapists were then asked via e-mail or post, to weight ‘buttoning’ against the other eight items, in order to include this weighting in the scoring. (Appendix E)

3.2.2 Criterion or Convergent Validity

Criterion-related or convergent validity is demonstrated when the test is effective in predicting indicators of a construct or in this case motor skills when compared to existing standardised tests. To establish criterion validity, two items of the task-based assessment were compared to two items on the standardised Bruininsk-Oseretsky Test of Motor Proficiency (BO) (21), namely threading beads and cutting. A limitation of the study was that only two items on the BO Test could be used as comparison.

3.2.2.1 Pilot Study 1

A pilot study was carried out at a Pre-Primary School in Gauteng. This school was selected by convenience sampling, as it included a population mixed in terms of gender, socio-economic background and culture. The principal gave her consent for the testing of the assessment to be undertaken at the school. She randomly chose 12 participants from the four Grade 0 classes and the parents of these 12 participants were asked to sign informed consent and give permission for their children to participate in the testing. The parent questionnaire containing questions relating to the child's activities in the afternoon, and the equipment available to the child at home, was included with the consent form. (Appendix F)
Ten participants, whose parents signed consent and who gave verbal assent were assessed at the school, where a room was made available for testing.

Each assessment took approximately 15 minutes and the participants were presented with the items in a varying order. The 10 participants were then re-assessed 4 days later, with the presentation of the items being varied again. The researcher scored each participant's performance on the scoring sheet while they were doing the tasks. (Appendix G)

3.2.2.2 Results from the Pilot Study

The results from the pilot study of the bilateral fine motor test items were compared to threading beads and cutting a circle, used in the standardised

Bruininsk-Oseretsky Test of Motor Proficiency (BO). (21) This indicated the extent to which the test scores accurately estimate an individual's current state in comparison to an existing valid test.

All the circles cut out by the participants were scored according to criteria set out in the BO, depending on how often the cuts went over one of the outer or inner concentric lines. The greater the number of times the participant cut over the lines, the higher the raw score and therefore the weaker the participant's scissor skill. A high raw score (many mistakes) converted to a low point score. The circles were also scored according to the researcher's previous study, where the length of the line actually cut was converted to a percentage score. These scores were then compared and discussed with the statistician. In this case a high score indicates good cutting skills, so these scores should correlate positively with the BO point scores.

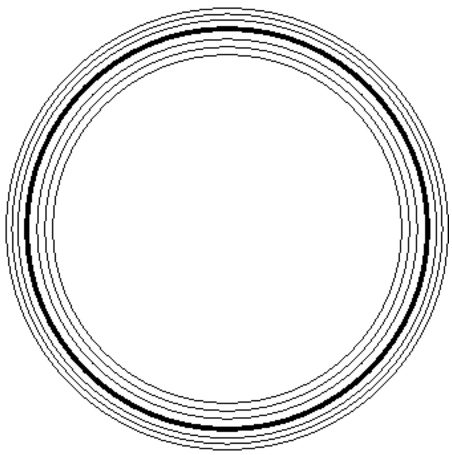


Figure 3.2 Circle with outer and inner concentric circles

This, however, was not the case and only three out of the 16 scores correlated well. The poor correlation of the BO and the percentage score was identified as being as a result of the way the cutting errors were being penalised in the percentage score. The percentage score was changed to allow for a margin of error, by not penalising cuts that were off but immediately next to the black line, within the first outer or inner concentric circle, used in the scoring. All the test results were scored again allowing for this change and the results re-analysed. (Appendix H)

Now, ten out of the 16 scores presented with a high correlation. A high score of 4 points on the BO now correlated with a score of 90% and above on the cutting task in the researcher's assessment. There was still a discrepancy with some of the other BO scores. However, as the BO is scored on a four point scale it is difficult to compare it to a percentage scale from 0 to 100. Because of this, the BO score is less sensitive and the percentage score gives a better idea, of how the cutting was to the actual line, as it did not measure only a fluctuation in cutting over the concentric lines.

Children were also scored according to the BO subtest of threading beads. Here, children were timed for 15 seconds, while threading beads. The number of beads threaded in that time was recorded. According to the BO test, the range is between 0 and 7 beads. This score correlated with the findings of this study. (Appendix H)

3.2.3 Construct Validity

Construct validity is an association between the test scores and the prediction of a theoretical trait. As described in the development of the test all items and scoring was designed based on activity analysis, motor skill theory and in consultation with Grade 0/1 teachers. Gaining information from the parents as to the children's activities at home further tested this.
During the validation of the test, items were looked at individually, and evaluated to see if they were sensitive enough for measuring bilateral skills in Grade 0 children. This was a process; the scores and observations obtained in the pilot study were used to evaluate each item in terms of construct validity.

3.2.3.1 Evaluation of the Test Construction

Factors in the administration and scoring of the test were noted and changes made to facilitate the ease with which the test could be used.

3.2.3.2 Test administration

The order in which the tasks should be presented was formulated. The items using a stopwatch were moved to the end of the assessment, as children should not be rushed through tasks where no emphasis was placed on timing. It was often felt that children tended to rush through tasks once they were aware that a stopwatch was being used, even if it was not used for the particular task they were doing.

The order of the tasks was therefore set as:

- Drawing with a ruler
- Name writing
- Folding paper
- Tearing
- Cutting
- Threading beads
- Lacing
- Tying shoelaces

3.2.3.3 Scoring

During scoring, it was noted that not all participants were necessarily doing the tasks in the way described on the observation form but several used different methods. These differences were then recorded on their individual sheets, revised and added onto the assessment sheets when the children were re-assessed for the second time. (Appendix I)

The scoring for the item - 'folding paper' had to be changed. It seemed evident that the children had not learnt a specific method of doing this and the responses varied a great deal. The scoring had to include more variance in the motor responses. (Appendix J)

3.2.3.4 Revision of the Assessment Items

- Drawing around an object was added after the first assessment. The asymmetrical bilateral tasks requiring stabilising with the non-dominant hand for example writing, did not allow for adequate observation of effective use of the hand when stabilizing. For instance, the child could place the non-dominant hand on the paper, and if the name was short and the child did not press hard with the pencil, then the paper did not move, although the quality of the actual stabilisation was poor. The researcher therefore included ‘Drawing around an object’ in the second assessment. (Appendix K)

- Lacing was excluded once the items were analysed. It was felt that ‘lacing’ did not give the researcher much information about the development of bilateral skills. All children used both hands and this did not fit into the asymmetrical bilateral tasks as they alternated between their stabilising and acting hands. This item was also similar to ‘threading beads’ and it was not necessary to include two similar skills in one test. Lacing was excluded, rather than threading beads, as this test could be compared to results of the Bruininsk Oseretsky Test.

- The task of ‘buttoning’ was added after discussion with other therapists (3.2.2.1) and will only be evaluated in the second pilot study. (Appendix L)

3.3 Test Reliability

3.3.1 Test-retest reliability

3.3.1.1 Pilot Study 2

The school at which the reliability testing was done wished to remain anonymous. Permission was obtained by the principal and informed consent was obtained from the parents of the participants who were selected through consecutive sampling by the principal. Seven girls and three boys were included, as the other boys were involved in a sporting activity on the day. Verbal assent was obtained from the participants.

The entire assessment battery, which required 10 -15 minutes of testing time to complete the nine items, was administered to each participant individually by the researcher.

The participants were presented with the items in the following order:

- Drawing with a ruler
- Name writing
- Drawing around an object
- Folding paper
- Tearing
- Cutting
- Threading Beads
- Tying Shoelaces
- Buttoning a shirt

During the assessment of the motor components used, the efficiency of the movement, as well as the time taken to complete a task was scored. Actual scoring of performances was done after completion of the assessments for the following: drawing with a ruler, writing on the line, tearing on a line, cutting and drawing around an object from observations noted during the assessment.

Only nine children were re-assessed by the researcher four days later, as one child was absent. Exactly the same procedure was followed in the re-assessment.

The scoring sheets were folded along the line between the first and second assessments, so that the researcher was blinded to the first assessment, in order to eliminate bias.

3.3.1.2 Results of the Pilot Study

Test-Retest Reliability was analysed in relation to the results of Pilot Study 2. This assumes that there will be no change in the quality or construct being measured from one test to the next. It is gauged by administering the test twice at two different points in time to assess the consistency of a test. Scores from Pilot Study 2 were captured and were then analysed including the random-effect multilinear regression and rho scores. Ten out of 26 constructs did not show a significant correlation between the first and second test administration.

Table 3.2 Test-retest Reliability of the Components of the Nine Test Items

Item	Aspect Number	Description	Rho scores (correlation coefficient)	p- Value
Cutting	1	Scissor grip	0	1.00
	2	Cutting motion	0.082	0.40
	3	Cutting a square (%)	0.864	0.00**
	4	Cutting a square (time)	0.652	0.01**
	5	Cutting a circle (%)	0.923	0.00**
	6	Cutting a circle (BO Test)	0.896	0.00**
	7	Cutting a circle (time)	0.701	0.01*
Drawing with a ruler	8	Ruler stabilizing	0.903	0.00**
	9	Ruler efficiency	0.437	0.08
	10	Ruler drawing	0.425	0.09
Name writing	11	Name stabilizing	0.5	0.05*
	12	Name accuracy	0	1.00
	13	Pencil grip	0.733	0.00**
Folding paper	14	Folding components	0.264	0.21
	15	Folding efficiency	0	1.00
	16	Folding accuracy	0.412	0.09
Tearing	17	Tearing components	0.517	0.04*
	18	Tearing accuracy	0.636	0.01**
Threading beads	19	Threading time	0.5	0.05*
	20	Threading components	0.889	0.00**
Tying Shoelaces	21	Shoelaces components	0.855	0.00**
Drawing around an object	22	Object components	0.585	0.02*
	23	Object efficiency	0.889	0.00**
	24	Object accuracy	0.169	0.30
Buttoning	25	Buttoning a shirt components	0.889	0.00**
	26	Buttoning a shirt time	0.136	0.34

* Significant $p \leq 0.05$

** Highly significant $p \leq 0.01$

3.3.2 Re-evaluation of the test construction

3.3.2.1 Analysis of the items and changes made

- <u>Cutting the square and circle (aspect numbers 1-7)</u> (Appendix M)

  The correlation scores of 0 and 0,082 for aspect numbers 1 and 2 were not statistically significant. This aspect involved the observation of cutting with scissors, while filling in the observation sheet on both the scissor grip as well as the cutting motion. Since the task was completed in a very short time, it made the observation of all of these aspects very difficult. It was decided to use a video camera to record the scissor grip and the cutting motion and then complete the observation sheet once the child had completed the assessment. This allowed for the assessment to be viewed several times, in order to complete the observation sheet correctly.

The correlation scores for aspect numbers 3 to 7 ranged between 0,652 and 0,923 for the cutting aspect of the circle and square as well as the time needed to complete the task. These results are statistically significant and thus this part of the assessment is accepted as reliable.

- <u>Drawing with a ruler (aspect numbers 8-10)</u> (Appendix M)
  The correlation score for item 8 - stabilizing the ruler where motor components were observed was 0,903, which is statistically significant. The lower correlation scores found for efficiency and accuracy were as a result of the ruler slipping off during one of the two assessments, resulting in one poor score. It was decided therefore to give the participant three trials in this task in order to eliminate accidental errors.

- <u>Name writing (aspect numbers 11-13)</u> (Appendix M)
  The motor component for this task, which consists of observation of the pencil grip was found to have a statistically significant correlation. However, further differentiation of the tripod pencil grip was introduced as it became apparent that many children used a static, rather than a dynamic tripod grip. Low scores for accuracy required alteration in terms of scoring the task as it was felt that the task was too difficult for children in Grade 0. They have not been exposed to writing on the line and thus some also assume they should write above the line, rather than on the line. A margin of error was introduced, allowing the child to write on the line and up to 1 mm above the line.

- Folding paper (aspect numbers 14-16)

  The correlation scores for this task ranged from 0 to 0,412, indicating poor test-retest reliability for all items assessed. Throughout the assessment it was observed that participants were not familiar with the task of folding paper and thus used varying approaches. In this case the motor components varied which also has an effect on the accuracy for example if the child aligns the centre of the paper first and flattens the paper using the thumbs, the accuracy generally is better, than when using the forearm to flatten the paper. The activity of folding paper is not a suitable test item for this age group. It should not be included as a task in this test and it was therefore removed.

- Tearing (aspect numbers 17-18) (Appendix M)

  Although the scores of 0,517 for the motor components and 0,636 for tearing accuracy were statistically significant, it was decided that the activity should be revised as the straight line presented could be torn in one movement. In order to ensure that the participants made small tears in stages, this was changed to a curved line as it was felt that this would result in a more organised and consistent approach.

- Threading beads (aspect numbers 19-20)

  The correlation scores ranged from 0,5 to 0,889 and were statistically significant. Test-retest reliability for this item was accepted.

- Tying shoelaces (aspect number 21)

  The correlation for this item was 0,855, which was statistically significant and the test-retest reliability for this item was accepted.

- Drawing around an object (aspect numbers 22-24) (Appendix M)

  The correlation for motor components used in this task was statistically significant, even though the participants had not consolidated their approach to this task, which was very varied. This task, however, is an important indicator for the development of bilateral skills, with the stabilization of the object throughout the activity, indicated by the efficiency with which the task is done. The correlation for that aspect was 0,889 and is statistically significant. Accuracy correlated at 0,169 (not statistically significant) probably due scores of either 1 or 0. Thus if the participant made any error, they were immediately penalised, and scored 0. By increasing the range of scoring, it made the test more sensitive to the skill and allowed for more differentiation of the skill levels.

- Buttoning (aspect numbers 25-26) (Appendix M)
  The correlation score for motor components was statistically significant One further motor component was observed while testing the participants as some of them did not close buttons with the arms in midposition, but rather in supination. This change was included in the scoring for this item. The participants will also be given three trials in this task to resolve the low correlation score by using the best out of the three scores obtained.

3.3.2.2 Weighting of the scores

Each test item was allocated a 'weighted number', which was then used for the composite score. Analysis used to establish the weighting used random-effects Generalized Least Squares (GLS) regression.

The scores were revised, as 'lacing' had been removed from the assessment. The weighted scores now ranged from the most important, to the least important as follows:

- Cutting (18,52)
- Tearing paper (15,39)
- Tying shoelaces (13,66)
- Drawing around an object (13,47)
- Buttoning (12,08)
- Threading Beads (11,33)

- Name writing (10,38)
- Drawing with a ruler (5,16)

This was further revised, once it had been had established which other test items would be removed from the assessment battery.

3.3.3 Test Reliability and Finalisation of Test Items

3.3.3.1 Pilot Study 3

Once all the alterations to the test items had been made a second test retest reliability pilot study was carried out. The school at which this pilot study was conducted wished to remain anonymous. Permission was obtained by the principal, as was informed consent from the parents of the participants who were selected through consecutive sampling by the principal. Five Grade 0 children were assessed individually on the first day and were presented with the items which had been altered or did not have statistically significant test-retest correlations in pilot study 2.

The items were as follows:

- Drawing with a ruler
- Name writing
- Drawing around an object
- Tearing
- Cutting out a square and a circle
- Buttoning

The revised observation sheets were filled in while the children were doing the tasks. Cutting out the square and circle was videoed. (Appendix N)

All children were then re-assessed 3 days later.

3.3.3.2 Reliability

The data was analysed for test-retest reliability as for pilot study 2 using the random-effect multilinear regression and rho scores.

Although some items were now at an acceptable level to be assured of the test- retest reliability, eight still did not prove to have statistically significant correlation.

Table 3.3 Test-retest Reliability for Six Adapted Tasks

Item	Aspect Number	Description	Rho scores (correlation coefficient)	Significance
Cutting	1	Scissor grip	0.8	0.00**
	2	Cutting motion	0.88	0.00**
	3	Cutting a square (time)	0	1
	4	Cutting a circle (time)	0	1
Drawing with a ruler	5	Ruler stabilizing	0	1
	6	Ruler efficiency	0	1
	7	Ruler drawing	0	1
Name writing	8	Name accuracy	0.42	0.16
	9	Pencil grip	0.88	0.00**
Tearing paper	10	Tearing components	0.75	0.02**
	11	Tearing accuracy	0.53	0.10
Drawing around an object	13	Object accuracy	0.74	0.02**
Buttoning	14	Buttoning a shirt components	0.36	0.20
	15	Buttoning a shirt time	0.81	0.01**

* significant $p \leq 0.05$

** significant $p \leq 0.01$

3.3.3.3 Analysis of the items and changes made

- <u>Scissor grip and cutting motion (aspect number 1-2)</u>

  The use of a video camera enabled observations on the video to be viewed several times, making the items reliable as the correlation was statistically significant for both.

  From the observation on the video it was evident that the following detail needed to be added in the assessment of cutting the square and circle.

  1. Did the child close the scissors in the corner when cutting the square?
  2. Did the child use a bilateral approach when cutting the circle?
  3. Which direction did the child cut (clockwise or anti-clockwise)?
  4. Was the cutting edge smooth?

5. Did the child cut out the shape only or did the child cut off strips of paper first, before actually cutting out the shape?
6. The accuracy and Bruininsk-Oseretsky (21) scores were recorded on the observation sheet.
   (Appendix O)

- <u>Time to cut out the circle and square (aspect numbers 3-4)</u>
  The correlation for cutting time was 0. It was decided, however, to keep this item in the test as comparing the speed and accuracy scores allowed for an observation in terms of the relationship between the two factors. Did the accuracy decrease as the speed decreased? Was the child able to maintain the accuracy with decreased speed?

- <u>Drawing with a ruler (aspect numbers 5-7)</u>
  The rho scores were 0 for all aspects of this item even with three trials. Since the reliability of this item was so poor, it was decided to remove this item from the test, as the scoring used did not seem to be sensitive to the participant's skill.

- <u>Name writing (aspect numbers 8-9) (Appendix P)</u>
  Although the correlation for the grip was 0,88, which was statistically significant, the accuracy, however, only had a rho score of 0,42. The task of writing on a line was too difficult for Grade 0 children as many will not have been exposed to this. It was, however, still included in the assessment, as this is one of the Grade 1 activities that is very important for the 6-7 age groups to master.
  The total points scoring for the pencil grip was adjusted after observations made during this pilot study to accommodate three fingers on the shaft of the pencil and a lateral grip.

- <u>Tearing (aspect numbers 10-11)</u>
  In pilot 2, the correlation score for accuracy of tearing on a straight line was higher (0,64) than in the pilot study 3 where tearing took place on

a curved line (0,53). The curved path influenced this and as the task became more complex, there was more variance in the accuracy. More information, however, in terms of bilateral development can be gained from tearing a curved path, as compared to a straight one, as more skill and control is required. Thus it was more important to observe the children completing the tearing of a curved path, even though the accuracy is not statistically significant.

- <u>Drawing around an object (aspect number 12)</u>
  The correlation score for accuracy was 0,74 and since this is statistically significant this item was retained in the test.

- <u>Buttoning (aspect numbers 13-14)</u>
  A participant's approach to this task varied a lot depending on the clothes they wore. This was not unexpected as many 5-6 year old children only learn to close buttons once they wear a school shirt in Grade 1. There was no statistically significant reliability in this aspect but it was retained in the test as this is also one of the important skills that is required once the child is in Grade 1. There may be variance in the motor components used when closing buttons, however, the timing aspect was more consistent with a significant reliability giving an indication of how fast children were able to close their buttons when putting on a shirt. This gives an indication of how fast children get dressed; an important task for getting ready for school in the mornings and also during school, when changing clothes for example in sports. Using the three trials for buttoning will be retained in the test.

3.3.3.4 Weighting of the scores

The scores were revised once the test items had been finalised. Analysis used to establish the weighting identified earlier was completed using random-effects Generalized Least Squares regression. The assessment items now ranged from the most important, to the least important with an attached weighted score as follows:

- Cutting (20.63)
- Tearing (16.13)
- Tying shoelaces (13.88)
- Drawing around an object (13.26)
- Name writing (12.29)
- Threading beads (12.24)
- Buttoning (11.55)

The total score of the weighted scores is 100, which can be used in the composite score.
It was later decided not to incorporate the composite score obtained from weighted items in this research, as the overall score was not necessary. This research compared items separately. The composite score, however, is important in the development of the assessment, and it is recommended that it be completed with the final development and testing of the assessment.

3.3.4 The Final Test Items of the Task Based Assessment

The final test sheet (Appendix Q) included the following items:

- Name writing
- Drawing around an object
- Tearing
- Cutting
- Threading beads
- Tying shoelaces
- Buttoning

These seven items represent a variety of bilateral skills done by Grade 0 children. They cover some personal management activities and some 'work-related' activities required for preparation for Grade 1. The test therefore included items that are functionally relevant to Grade 0 children in South Africa and that give an indication of how these children would cope in classrooms in the South African context. The test items showed good test-retest reliability.

Aspects of the task based assessment that were considered to give it validity included the scoring which was adapted and changed several times in order to be sensitive enough to measure a range of performance. The instructions used little verbal input and were mainly visual, as the aim is to assess a child's motor function and not the understanding of instructions or language skills. The test used functional tasks which equates with what occupational therapists are aiming towards in their therapy, namely children's function in their occupational performance areas within their environments.

The task based assessment was used for the purpose of this study. It will, however, be finally developed to be used by occupational therapists, to evaluate bilateral fine motor co-ordination in Grade 0 children. Further development will require that more children are assessed for standardisation of norms. Another item, namely that of colouring in, could possibly be added to the assessment battery. This task based assessment could be used in conjunction with other assessment tools available to South African Occupational Therapists.

4. PROGRAM DEVELOPMENT – CHAPTER 4

South Africa is a country of diversity with many races with different languages, socio-economic levels, educational levels and health issues. Children are affected by their birth history and environment. This includes parenting, health, as well as care leading up to the pre-school years. Although there are schools in which integration has occurred after a decade of political transition, in many there is little change. Schools still cater to separate socio-economic and racial groups. (25) 85% of learners in South Africa attend schools where more than 50% of those at the school are from economically disadvantaged backgrounds. (88)

Resources have shifted towards these previously disadvantaged schools, but overall matriculation results have not improved in the post-apartheid period, reflected in poor pass rates with high standard deviations. Thus the school system does not contribute substantially in the upward mobility in the labour market. (89) Roughly 25% of South Africa's children have failed Grade 1 over the past 30 years, (25, 90) while the percentage pass rate for matric examinations in South Africa has decreased from 70% to 65% over the period 2004 to 2007. (91)

Usually, the measurement of development of socio-economically disadvantaged children, only starts at six years of age, when they start formal schooling in Grade 1. This assessment reveals that by the time children start in school, gaps already exist between racial and ethnic groups. (28) It may be postulated that these gaps could be closed during the school years. However, Rouse et al (2005) found that incompetences, found in high school students, are already present when children start school. This means that children who enter school without being school ready and have either social, emotional or academic deficits, carry their problems with them. (28) This indicates the need to investigate school readiness and it demonstrates the need for programs that can enhance the children's readiness. (25)

Factors affecting school readiness are multi-faceted. A child's development is affected by many different factors such as birth weight, general health and diet, nursery schools attended and their quality. Parental input such as speaking to one's child, reading to them, stress levels in the home etc also play a role. Many factors are not measurable. (92)

Each of the developmental theorists described development according to a slightly different framework. However, each one plays an important role in understanding the wide impact on a child. A child whose basic needs such as food or safety are not met (32) will find it difficult to learn. A child who lives in poverty is not exposed to a multitude of activities due to lack of funding. A child who is not exposed to nursery school misses out on many learning opportunities. Many children are not able to enjoy the positive impact the environment can have on their development. This is prevalent in the South African context. (25)

A study by Masitsa (1988) highlighted the impact of environment on development. Pupils who attended a pre-primary school performed significantly better at school than those who did not attend. Children who owned educational play material performed academically better; further, children who lived in houses, rather than shacks performed significantly better. (25)

In order to progress forward, we need to provide opportunities for children to learn and develop, not by decreasing the standard, but rather by improving our services and giving each child the means to progress. Inadequate stimulation and interactions, amongst other factors can affect a child's development through disrupting basic neural circuitry. Strategies to promote child development should thus include stimulation, including programs that provide direct learning. (26) Past research has recommended that activity programs which target specific motor skills should make up part of this learning. (5, 27) Further, there is evidence that early intervention can result in rapid improvements. (93)

Each child needs opportunities to exercise large and small muscles and the critical period for fine motor control development is believed to start around age two and begin to wane at about age ten. The critical period represents a window of opportunity during which the child is maximally sensitive and also responsive to certain input. It is during this time that the neural pathway area of the brain and also skill develops as it should. (7)

Parents should be encouraged to provide stimulating environments for their children. (25) There is, however, a need for enrichment programs to counteract effects of deprivation. An intervention program developed by Herbst, Schoeman and Huysamen (1993) for preschool Sotho children proved successful when comparing the children's cognitive and motor development to a group of children who had not been exposed to the program. Liddell and McConville (1994) found the effects of a South African home intervention program small to moderate. They suggested parent education in terms of home environments, parenting skills as well as networking with educational partners. (25)

To increase the level of functioning of children in Grade 0 in South Africa would be beneficial, not only to the individual, but also to the population in general. (7) One would do this by ensuring that children are exposed to high-quality educational programs. (28)
Suitable programs can be used to assist children who have little input from their environment. They can be used to improve development and allow for skill acquisition. An occupational therapist is able to develop such a suitable program, using therapeutic knowledge, an in-depth understanding of development, activity analysis and background understanding of norms and requirements in order to cope effectively within the child's age group. There is much variance in the acquisition of skills. Skills are learnt over time and the question arises, how much practice is required for a skill to be considered acceptable? When looking at children learning new tasks, the developmental appropriateness should be considered. (20, 26) A child requires the underlying performance components like co-ordination in order to develop specific classroom skills. Further, the difficulty of the skill will determine the amount of practice it will take to consolidate that skill. (8)

Looking at school readiness and taking into consideration the importance of fine motor skills in Grade 1, the development of scissor skills was selected. The aim of the program was to assist five to six year old, Grade 0, children from various backgrounds to improve their performance in scissor skills, a bilateral fine motor task. In South Africa children come to Grade 0 with different backgrounds, different exposures and experiences. It was thus important to make the program broad, in order to allow for participation of all children, irrespective of previous experiences. The first aim of the program was to grade the program so that it would allow all the children to move along the continuum of development from beginner to highly skilled performer. (43) This would include repetition of a familiar skill for some of the children, while for others, it would be a completely new task. The second aim was to allow for the development of scissor skills to a point which would decrease the gap in skills that is present between groups of children. Thus all children completing the pre-school year should be at as similar point on the developmental continuum as possible, and school ready in terms of scissor skills. (43)

The most advanced method of cutting includes the ability to correct the process and make adaptations while the child is cutting, thereby being able to maintain the scissors on the line all of the time. This also includes the involvement of the non-dominant hand in adjusting the paper while cutting. Then the child is required to monitor the speed with which s/he cuts, allowing enough time to correct the process of cutting. This is described as the final stage of motor learning, where the person is able to identify and correct movement errors during the performance, if that performance is slow enough. (43)

In preparation for the development of a program for Grade 0 scissor skills the process involved evaluation of existing programs. Five commercially available programs compiled to be used by teachers were analysed by describing the components of the programs. (Table 4.1) Based on aspects of these programs, the researcher then developed a suitable scissor skills program for South African children.

Pilot study 1 validated the program. A focus group of occupational therapists was conducted for construct validity of the program, where therapists commented on the suitability of the pictures, grading, level of difficulty and a practice/picture match.

A revised, New Scissor Skills Program (South African Scissor Skills Program SASSP) was then developed, taking into account the pilot study as well as the focus group.

4.1 Available Scissor Skills Programs

There are many scissor skills programs available both in print and advertised on the internet. Five commercially available scissor skills programs were compared and analysed. The following aspects were discussed: the length of the program; the number and type of picture used; grading of the pictures; inclusion of a practice component as well as a checklist for teachers. This provided insight into programs that are already available and to assess trends for incorporation into the scissor skills program for this study.

The following 5 programs were reviewed (Appendix R):

Scissor Skill (PreK – Gr 2) (94)
Learn to Cut (95)
Developing Basic Scissor Skills (96)
Cutting Activities (97)
Shapes to Cut – Animals (PreK – 1) (98)

4.1.1 Scissor Skills Programs

Table 4.1 Review of Five Scissor Skills Programs (Shortened Version)

<table>
<tr><td>Name</td><td>Scissor Skill (94)</td><td>Learn to Cut (95)</td><td>Developing Basic Scissor Skills (96)</td><td>Cutting Activities (97)</td><td>Shapes to Cut (98)</td></tr>
<tr><td>Program length</td><td>This program has 60 picture pages.</td><td>This is a comprehensive cutting program (343 pages), with 61 individual art projects.</td><td>This program has 8 activity pages.</td><td>This program consists of 40 pictures.</td><td>This booklet includes 28 pictures.</td></tr>
<tr><td colspan="6">Comment: If intending to develop a skill, a suitable length of a program is required. A skill such as cutting with scissors, which is a complex bilateral task, will need more practice, than for instance threading, a slightly easier bilateral task. (8) Exactly how long this program should be has not been researched; however, 8 activity pages most probably are not enough.</td></tr>
<tr><td>Pictures</td><td>Pictures are grouped into seasonal pictures. 5-6 are allocated per month. The educators are therefore able to use them in themes discussed in the class.</td><td>The pictures focus mainly on the shapes practiced, rather than combined patterns (for example no animals).</td><td>There are only 8 pictures that can be cut out, half of which are greeting cards.</td><td>Appealing pictures and projects have been included, however, some themes are repeated and pictures are very similar.</td><td>Only animal pictures are used;
they are very appealing for children.</td></tr>
<tr><td colspan="6">Comment: When children are motivated, they are eager to participate and to put effort into the activity. Thus presenting appealing pictures is very important. (8) Pictures such as in ‘Learning to Cut’ strictly adhere to the practice component, thus slightly limiting the variety of pictures. It is often not realistic having designs with corners and circles only, but rather a combination of corners and curves, as one would see in for example an animal picture.</td></tr>
</table>

Picture Grading	The program overall is not graded from straight lines, to corners, to curves.	Pictures are not graded in terms of level of difficulty.	The picture pages are graded from straight lines to curves.	The pictures are not graded at all; they vary from straight lines, to curves and circles.	Generally pictures have round corners and gentle angles for cutting. Thus only one aspect of cutting is observed and the change of direction, as in sharp angles is ignored.
Comment: Pictures vary in their difficulty – straight-line designs are easier to cut than complicated curved designs with much detail. (5) Although pictures are not as easy to grade as practice components, where only a particular shape is used, there is still a general trend for grading.					
Picture Grading – Line Thickness	All of the pictures have a line thickness of 1,5 to 2mm.		The picture pages have very thin lines (less than 0,5mm) and there is no grading for the line thickness.	In the program, the line thickness is constant at less than 0,5 mm, which could be viewed as a goal, rather than a starting point.	There is no grading from one picture to the next. Each picture in itself has varying line thickness. However, this varies from 1mm to 3 cm or more, which is a very wide range.
Comment: Line thickness is an important aspect to look at, as it allows the child to stay on the line and thus develop the skill of cutting on a line. Correct visual feedback of maintaining the scissor on the line reinforces the development of this skill. The skilled person is able to perform a task and while performing he can recognise potential mistakes and also correct them if necessary. This is possible when the line thickness is thick enough to allow for correction of movement. (43)					
Practice	There are 7 practice		There are 7 practice	There is no practice	The booklet has no

	pages, which include a wide variety of lines to be cut out including straight lines, angles and also curves.		pages.	component at all.	practice components.
Comment: A practice component could be used to reinforce a skill that needs to be learned. Learning happens through practice and thus a practice component would emphasise this. (8) Further, the practice component can concentrate on a specific shape only, reinforcing only that, whereas the picture generally has a combination of shapes.					
Practice Grading	The practice lines do not vary, thus the same lines are practiced with each corresponding picture page.	The practice pages are graded from snipping, to cutting a straight line, to cutting a simple shape, to cutting a complex shape. The shapes are graded in terms of their level of difficulty i.e. squares, rectangles, triangles and diamonds are done before circle, oval, crescent, heart and star.	The practice pages are graded from straight lines, to lines with corners, to curves, to circles and to ovals. There are only 7 variations in the practice of cutting skills.	N/A	N/A
Comment: The practice component can be used to introduce cutting of various shapes. As this is not limited to pictures, it is easier to control and also easier to grade from straight lines, to corners, to curves. Corners can further be graded from large angles to smaller angles, requiring					

more manipulation of the paper. (5) The task is thus graded from simple to complex. (13)					
Practice Grading – Line Thickness	The straight line starts with a 3 mm line thickness. All other practice lines are between 1 and 2 mm.	The line thickness decreases from 6mm to 2-3mm. The 6mm line thickness is used every time a new practice is introduced and it decreases as the same practice is repeated.	The line thickness is decreased from 1, 7 cm to 3mm.	N/A	N/A
Comment: The line thickness enables the child to learn to stay on the line. This needs to be the 'just right' challenge. A line, for instance, that is too wide, allows for much fluctuation when cutting, rather than gently guiding children into cutting along a more narrow path. (13) When changing from one pattern to the next, i.e. where the pattern becomes more complex, the overall difficulty can be made easier by increasing the line thickness. (5, 99) The change from one thickness to the next should be graded and not be too drastic. (13)(13)					
Solid versus Dotted Lines	Two of the practice lines have dotted lines, as opposed to solid lines.	All of these pictures have dotted lines for cutting (width 2mm and some 1mm).		Dotted lines are used.	
Comment: One should be teaching cutting on a line, rather than including a perceptual component in this case visual closure, which is not inherent in the cutting skill. (13) Cutting on a dotted line is more complex than cutting on a solid line as the child has to incorporate the					

perceptual aspect of the task.					
Skills Checklist	The teacher is able to record the children’s names as well as the ability to cut the practice pages.	The program includes pre- and post-tests that measure the achievement for each skill. Each pre-test item is paralleled by a structured worksheet. A recording sheet is included for tracking each child’s tests and daily progress.	A classroom checklist is provided where each child’s skill level is recorded.	Educators do not record the progression of the skill.	Educators do not record the progression of the skill.
Comment: A checklist is a good guide to keep track of children and their skill development. (13) However, in a class where there are many children, this can become an overwhelming task, if too much administration and detail is required.					

4.2 Development of a South African Scissor Skills Program (SASSP)

4.2.1 Overview

Considering the limitations of the programs described in Table 4.1, a graded SASSP was developed, based on a series of worksheets, suitable for Grade 0 children in South Africa.
The development of motor skill, bilateral hand function, scissor skills, dominance, as well as the interests of 5 – 6 year old children were taken into consideration.

The program was designed to be completed within the classroom over a short time period of 10 weeks, so that changes in the children's cutting ability at the completion of the SASSP could be attributed to the program, rather than 'motor maturation' or participation in a general class routine. This is important as the changes measured can be linked to the intervention for generalisation to a larger population. The program was therefore limited to 50 worksheets, which it was estimated would allow enough practice for children to develop adequate skill.

Pictures for the program were chosen by looking at many children's books, as well as games with clear, single line drawings. Selection depended on the pictures being those that South African children could relate to. The South African flag was used, as well as animals such as a lion or farm animals found in this country. A graphic artist drew the pictures on a computer and adapted the line thickness within the various drawings as required to grade the program.

4.2.1.1 Choice of paper and scissors for the SASSP

The SASSP was reproduced on A4 80 g/m2 paper as children of this age group are often already exposed to photocopied material and therefore are required to be able to cut paper of this thickness and size. Lower grammage paper such as a magazine paper was excluded, as this paper tears easily and makes the skill of cutting more difficult. Right- and left-handed scissors were used by the children, depending on their dominance, or the preferred hand for cutting. (Some left-dominant children cut with their right hands). Scissors made for children were used, so they could fit into the child's hand. Round-nosed blades were selected, as these were perceived to be safer than pointed blades. (20) Several brands of scissors were evaluated and it became apparent, that many did not cut well, unless the blades were angled to the paper. These were not chosen, as children who are learning to cut out should be able to practice the skill without concentrating on the tool or having to correct the position of the tool. Round-nosed Basteline scissors were therefore chosen as the most suitable for this study.

No other fine motor aspects, such as colouring, pasting, glueing or folding were included in the program, as the purpose of this study was to develop a program that measured only scissor skills.

4.2.2 Program components

As a result of the review of existing programs, it was decided that the program should have a practice component as well as a picture component. The practice and picture components were linked in terms of difficulty. Thus, each of the 50 worksheets was divided by a line in the middle with a picture component at the top and a practice component below. Each worksheet would be cut on this line, to divide it into two A5 pieces. The thickness of this dividing line deceased from 3mm, to 2mm and finally 1mm thickness as the program progressed, requiring the children to cut on a thinner line as their scissor skill improved. The practice design would always be cut out first, followed by the picture. The practice component was designed to contain repetitive patterns and was thus not as interesting to cut out. Cutting out the picture would therefore be the 'reward' once the practice was completed.

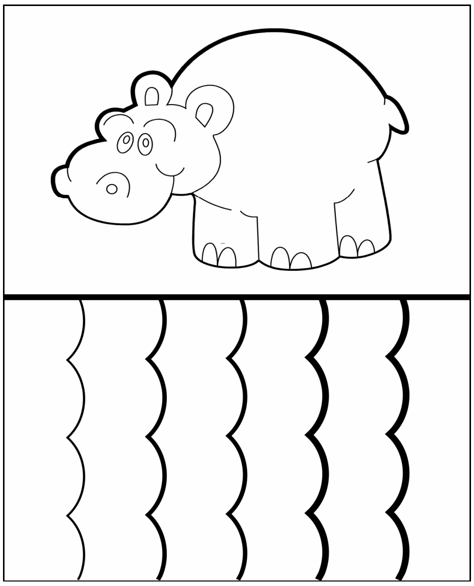


Figure 4.1 Sample of the SASSP

This figure shows the practice component at the bottom and the picture component at the top. Varying line thickness can be seen in both the practice and the picture component.

4.2.3 Grading of the practice component

When designing the practice component, a previous study on 167 four to six-year old children from varying socio-economic backgrounds was taken into account. (5) Accuracy measurements when cutting out seven basic shapes revealed that children were best able to cut out a straight line. This was followed by a corner (square and triangle), a semi-circle, a crown, a spiral and lastly a circle. (5) The practice component of this scissor skills program was therefore graded accordingly:

1. Straight lines
2. Zigzags (130 degree)
3. Square spiral (90 degree)
4. Zigzags (70 degree)
5. Frog-jumps

6. Gentle wide wave
7. Top straight line with bottom circles cut out
8. High waves
9. Top and bottom circles joined in a pattern
10. Spirals
11. Circles

In contrast to the commercially available programs, rather than presenting the practice in the middle of a blank page, each practice design started at the edge of the paper, to guide and teach the child where and how to start a cutting task. This develops the correct approach to a cutting task and also helps those children who have planning problems, as these children often struggle to cut towards a shape in order to cut it out. Children with planning problems as well as those that have not been exposed to cutting, were often found to cut off strips of paper in order to approach the shape and only then cut on the line. The aim of the program is to teach the skill of cutting and by being provided with the correct approach children learn to execute this skill correctly and efficiently.

4.2.4 Grading of the picture component

The design of the pictures were graded in a similar way to the practice component and matched in terms of difficulty. Generally, pictures did not consist of one element like straight lines or circles only. Pictures consisted of a mixture of these lines and were thus graded according to the angles of corners, as well as the frequency of corners versus curves.

The pictures in the program were graded according to the following:

1. Straight line pictures with few changes in direction and also easy corners. (for example 90 degree corner is easier to cut than a 25 degree corner)
2. Straight line designs with many changes in direction.

3. Pictures with gentle curves
4. Pictures with prominent curves
5. Pictures with circular parts present
6. Pictures with many changes in direction
7. Pictures with more detail (complex designs)

4.2.5 Line thickness

Grading was introduced with respect to line thickness, which ranged from 3mm to 2mm and finally 1mm. It is easier for a child to cut on a thick line (3mm), as the path is wider and thus allows for some fluctuation in scissor control. A thinner line (1mm) requires the child to control the scissors more accurately. 3mm was used as a starting point, rather than 6mm or more as in the reviewed programs, as this thickness was appropriate for the skill level of five to six year olds. (5)

Each group of practice designs in the program therefore started with a 3mm line thickness, decreased to 2mm and then 1mm. Each time a new pattern was introduced the line thickness increased to 3mm again for the first few items. This then decreased to 1mm within the next few practice pages. Thus, as the complexity of the design increased with respect to angles or curves, the line thickness was initially increased in order to simplify the task. This was to allow the child to learn a more complex aspect of the task, without getting frustrated by the need for accuracy. As their skill developed on a given pattern this was graded, by decreasing the line thickness.

A program that teaches and allows practice of scissor skills on a 3mm line alone does not adequately prepare children for the skill and is not reflective of the ability of Grade 0 children. Further, when looking at pictures that children cut out in class, as well as ruled pencil lines that require cutting, these are generally thin lines. Thus the expectation of cutting on a line in Grade 0 is that of cutting on a line of less than 3mm in width.

Within the picture component, the line thickness was varied, so that at some point of the drawing the line thickness was 3mm and at another, it was 2mm or 1mm. This was varied according to the actual picture. Part of the picture was thus made easier by increasing the line thickness. The aim of changing the line thickness within the picture was to motivate children to complete the task to the best of their ability. Generally pictures appeared easier to cut out when the line thickness varied, compared to those, where only one line thickness was present.

4.2.6 Record Keeping

For this scissor skills program, all children would start with picture one and move through to picture 50. Performances would not be noted by the teacher and no sections would be done more than once.

There are many schools in South Africa where the average class size is 45 learners. (88)

It is difficult for a teacher to manage a class of this size thus the activities in the class should therefore be as easy to carry out as possible. The administrative side of tasks should be eliminated as far as possible. The aim was to plan and design the program in such a way, that children would improve their skill level, as they moved through each step in the program, without the teacher having to monitor each child individually.

No child should have to repeat the same picture, no matter what the quality of the cutting out was. Rather, the length of the program should cover the steps in the development of scissor skill, so that all children progress through repetition of the task and the grading of the program.

Children would be assessed by the researcher at the beginning and at the end of the program in order to analyse progress; thus there would be monitoring, however, not within the classroom environment.

4.2.7 Teacher Instructions

Attached to the program was an instruction sheet for teachers to use. This included the correct scissor grip as well as detailed instructions on how to administer the program in the class. (Appendix S)

4.3 Validation of the scissor skills program

Items in the program were piloted to determine the validity of the picture selection and sequence as well as to establish whether there were any problems with the instructions as this would be used by the teachers as skills-building in the classrooms. In this context, validity means that the program is in fact a scissor skills program and that it measures scissor skills at a Grade 0 level. (100)

4.3.1 Content validity

4.3.1.1 Pilot Study 1

A pilot study to validate the program was carried out at a Pre-Primary School in Gauteng. This school was selected by convenience sampling, as it included a mixed population including gender, socio-economic background and culture. Some of these children had previously attended a nursery school, whereas others started their school career in Grade 0. The principal of the school randomly selected 12 participants from the four Grade 0 classes. Ten participants whose parents signed consent participated in the pilot study.

The program was validated in terms of the skill of cutting, and appropriateness of the level of difficulty for the five to six year old age group, as well as what effect the practice and pictures had on the children's motivation to participate. Eight pictures were chosen for the validation of the scissor skills program as they represented a wide variety of scissor skills to be developed by the program including varying line direction, shape and line thickness.

The following represents the selection of the pictures for validation of the content of the program.

Table 4.2 Properties of Pictures selected for the Validation Pilot Study

Picture	Practice
House: 7 changes in direction with at most a 90 degree corner	Straight line with 2x 3mm; 6x 2mm
Plane: 16 changes in direction	Straight line with 4x 2mm and 4x 1mm
Train: 26 changes in direction	Straight line with 2x 3mm and 6x 2mm
Crocodile: 46 changes in direction	Square spiral decreasing from 3mm to 1mm
Apple: rounded shape with 8 corners and some straight lines	Circle 3mm
Snake: spiral shape	Circle 2mm
Earth: circle	Circle 1mm
Wheel: circle	Circle 1mm

Teacher instructions were drawn up which contained an explanation of how to run the program as well as a description of scissor skills which included scissor grip, cutting motion and cutting approach.

The eight pictures and the teacher instruction sheet were used by the principal of the school to carry out the validation pilot study with the 10 participants. The principal did not want to include other teachers, so as not to disturb the every-day class activities. She completed the 8 cutting sheets with all participants simultaneously over a period of 8 school days (1 per day). Paper and scissors were provided to control for variation in the materials and equipment.

4.3.1.2 Results from the Pilot Study

Feedback from the principal indicated that the instructions were clear and easy to follow, the correct scissor grip was implemented with the children and they had enjoyed the pictures that they cut out. The principal commented that the children had enjoyed cutting out the practice patterns as well as the pictures.

The 8 completed pictures were evaluated by the researcher to assess their appropriateness in terms of the children's ability to cut these types of shapes and lines. Pictures were evaluated according to the accuracy only, allowing a 1mm deviation from the thin lines as suggested by Bruininsk in their test for fine motor co-ordination. (21) Thus the practice and picture components were evaluated in terms of the ability to stay on the line while cutting.

Straight lines – This was a good introduction to the scissor skills program as the participants were able to cut on the line, even at the 1mm line thickness, with varying accuracy.

The square spiral - This practice component has two designs that are mirror images. One design is for a right-handed child to practice, and the other is for a left-handed child to practice. Thus although it was intended that only one of the designs should be cut out, during the pilot study, it was noted that all participants cut out both of the designs. It was also noted that many children tended to over-cut in the corners. The instructions were thus changed on the instruction sheet, to clearly explain mirror patterns as well as cutting corners. (Appendix T)

The circle – In general, children tended to cut inside the actual circle. Instructions were thus changed, in order to emphasise the correct approach to cutting circles. (Appendix T)

When cutting out the pictures, there was a general decrease in quality of the scissor skills as the complexity of the patterns increased. The actual study will reveal if the program is long enough to improve the skill level, as pictures become more complex. In general, the children seemed to understand the concept of cutting the outline of the picture (except for the wheel, where all participants cut the spokes as well). The wheel was excluded from the final program.

The pilot study proved that the content of the program was valid in terms of the level of five to six year olds scissor skills, that it was graded to challenge the development of further skill and it provided motivation in terms of participation.

4.3.2 Construct Validity

4.3.2.1 Focus Group

Construct validity is an association between the program and the prediction of a theoretical trait. (100) The program was designed based on analysis of existing programs and knowledge of activity analysis and motor skill theory.

In a focus group, the completed program (50 worksheets) was handed out to a panel of 12 occupational therapists that had at least 8 years experience in the paediatric field of practice. The program was discussed according to practice and picture selection, grading, line thickness and its length.

4.3.2.2 Results from the focus group

- **Practice selection**

Therapists liked the idea of the practice component. They felt that a wide variety of patterns was included and that it covered the various steps needed in the development of the skill.

- **Picture selection**

Most therapists liked the pictures and felt they were appropriate for that age group. One therapist felt they could be more exciting and the addition of cartoon images was recommended. (Appendix U)

- **Grading**

Therapists commented on the grading of the program based on their working experience. They agreed with the grading of the patterns. However, they debated the level of difficulty of the practice patterns. It was, however, agreed, that they should remain in the program, to be further assessed in the study with Grade 0 participants.

There was some disagreement in terms of the grading of the picture component. The general trend from straight lines to curves seemed to be correct, yet some pictures that were placed further to the back in the program appeared easier to cut out, than those presented earlier. They felt pictures should become increasingly more difficult throughout the program. Some therapists, however, commented, that it was not that critical if 2 or 3 pictures were slightly easier towards the back of the program, as all children would be cutting all of the pictures and thus be exposed to the whole range of difficulty. (Appendix U)

- **Line Thickness**

It was agreed that the inclusion of different line thicknesses was appropriate and that the range from 3mm to 2mm to 1mm was adequate.

- **Program Length**

Therapists felt that the length of the program seemed adequate to develop scissor skills in that age group, especially for those children who had been exposed to previous cutting tasks. It was debated, if the length of this program would be adequate for those children who had no previous cutting experience. It was agreed, that a study was needed to evaluate this.

Construct validity was established, as the panel of occupational therapists discussed the practice and picture selection, grading, line thickness and the length of the program. It was concluded that the skill of cutting at a Grade 0 level was being developed.

4.3.3 Parent questionnaire

When looking at the pilot study completed by the children, it became apparent that all children were able to cut and had previously been exposed to this skill. Only one of the children had not previously attended nursery school, before entering Grade 0. However, that child was at home with a mother that did not need to work. Although most parents worked full-time, they indicated, that they still spent time with their children when they got home. Further, they also had equipment readily available for the children, who were allowed to use this on their own. Equipment included colouring pencils, paintbrush and paint, paper, beads, scissors, kokis and play dough. Activities that parents did with their children included painting, creative work, colouring, games, reading, perceptual activities, ball games, cutting, swimming, riding bicycle, lego and counting.

The parent questionnaire (Appendix F) added valuable information in terms of previous exposure, resources at home and exposure to other activities.

4.4 South African Scissor Skills Program (SASSP)

All comments were taken into consideration and the following changes were made to the scissor skills program:

All of the pictures were re-drawn by a graphic artist to make the pictures more appealing for young children. The pictures were again graded according to level of difficulty, taking into account the comments that had been made in the focus group of occupational therapists. Once the pictures were in the correct order of difficulty, they were then combined with the matching practice component.

Due to time limitations for the following study where the program was to be used in Grade 0 classrooms, only 41 of the original 50 pictures were included in the SASSP.

Table 4.3 SASSP Summary

Program length	This program has 41 pages.
Pictures	Pictures include wild animals, farm animals, fruit, house, boat, South African flag.
Picture Grading	The program overall is graded from straight lines, to corners, to gentle curves, to prominent curves, to circular parts, to pictures with many changes in direction, to finally complex designs.
Picture Grading – Line Thickness	This ranges from 3mm to 1mm. Some pictures have one line thickness only, but most of them vary in thickness.
Practice	There are 41 practice pages.
Practice Grading	The practice component is graded from straight lines, to zigzags (130 degree), to square spiral (90 degree), to zigzags (70 degree), to frog-jumps, to gentle wide waves, to top straight line with bottom circles cut out, to high waves, to top and bottom circles joined in a pattern, to spirals , to circles.

Practice Grading – Line Thickness	Each new practice pattern starts with a 3mm line thickness, which is then decreased to 2mm and finally 1mm.
Solid versus Dotted Lines	Solid lines are used only.
Skills Checklist	The teacher does not have to track individual children. Pre- and post assessments were implemented.

4.5 Conclusion

The aim of this part of the study was to develop a suitable scissor skills program for Grade 0 children in South Africa. This was done by reviewing available programs, evaluating them and then developing the SASSP. The SASSP was validated by a pilot study and also by a focus group of occupational therapists.

Taking the above into consideration, the program was revised and completed, to be used in the implementation phase of the study. The effect of the program would be evaluated in terms of the grading to establish whether it allowed the development and improvement of scissor skills as a pre-requisite to other skills such as handwriting, in the normal population. Further, skill retention, transferability of fine motor skills and the effect of presenting the program at different times of the year was evaluated, as well as issues such as equivalence and 'maturation'.

5. RESEARCH METHOD – CHAPTER 5

5.1 Study design

The many objectives of the study required a number of phases in the implementation of the study. Various research designs were also used.

5.1.1 Phases of the study

This study consists of two phases, namely the developmental phase (discussed in chapters 3 and 4) and the implementation phase. The developmental phase included the development of the assessment, as well as the development of the scissor skills program. The implementation phase included the assessment of the children, as well as the implementation of the program. This will be discussed in more detail in this chapter. The following flowchart presents a summary of this design.

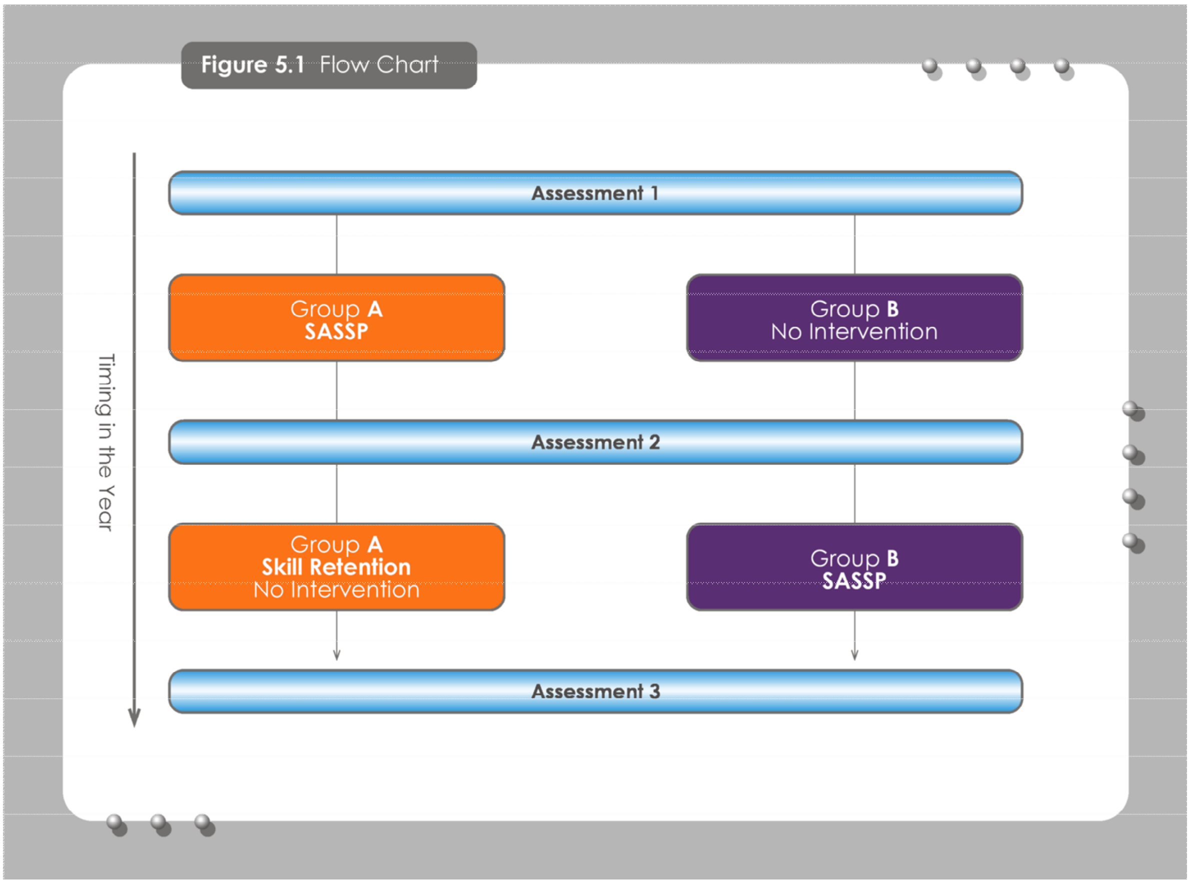


Figure 5.1 Flow Chart of Research

Overall, a quasi-experimental pretest-posttest longitudinal design was used. This involved a time series with periods of intervention (10 weeks) and no intervention (10 weeks) resulting in intra group and inter group comparisons.
A quasi-experimental design was chosen as the study had groups that acted as control and experimental groups, but these groups could not be randomly selected. This allowed for the effect of the dependent variable of bilateral fine motor skills to be evaluated in terms of developmental maturation and participant demographics in terms of their attendance at schools from different socioeconomic areas.
The concern with all of the quasi-experimental designs involves the method of choosing participants. Participants were selected in terms of the socioeconomic status of the schools they attended and not their individual socioeconomic status. Although not all variables can be controlled for in a quasi experimental design, this design gave the study greater external validity as intervention was carried out in a real world condition – the classroom.
The design was feasible in terms of the time constraint of one year in which the participants were in Grade 0 and the logistical constraint of the number of Grade 0 classes in some of the schools. The intervention in terms of scissor skills had to be carried out in a given class of Grade 0 children to prevent contamination to the children in the other class who were acting at controls at some point in time. (101)

The longitudinal component of the study was to evaluate the effect of an intervention to develop scissor skills in groups over time. The study included an intra-group aspect, where a group of participants were followed over time in terms of the change in their bilateral fine motor skills. The pre-test and post-test component was included in the aspect that involved assessments before and after the classroom based scissor skills (SASSP) intervention. (101)

The longitudinal time series also included a period when each Group A was re-assessed after a period of no intervention. This allowed for the measurement of retention of the scissors skills. The intervention in terms of scissor skills (SASSP) was introduced to the groups at different time periods in the year so the effects of normal class development could also be accommodated.

An inter-group component was introduced in that three different groups of individuals from schools with differing socioeconomic status were compared as to the change in their bilateral fine motor skills over time. In this study, overall change in the skill developed in cutting with scissors, the specific skill targeted by the SASSP, was compared to the overall change in other bilateral fine motor tasks. (101)
This addressed the objective set in terms of transferability of skill. (Figure 5.2)

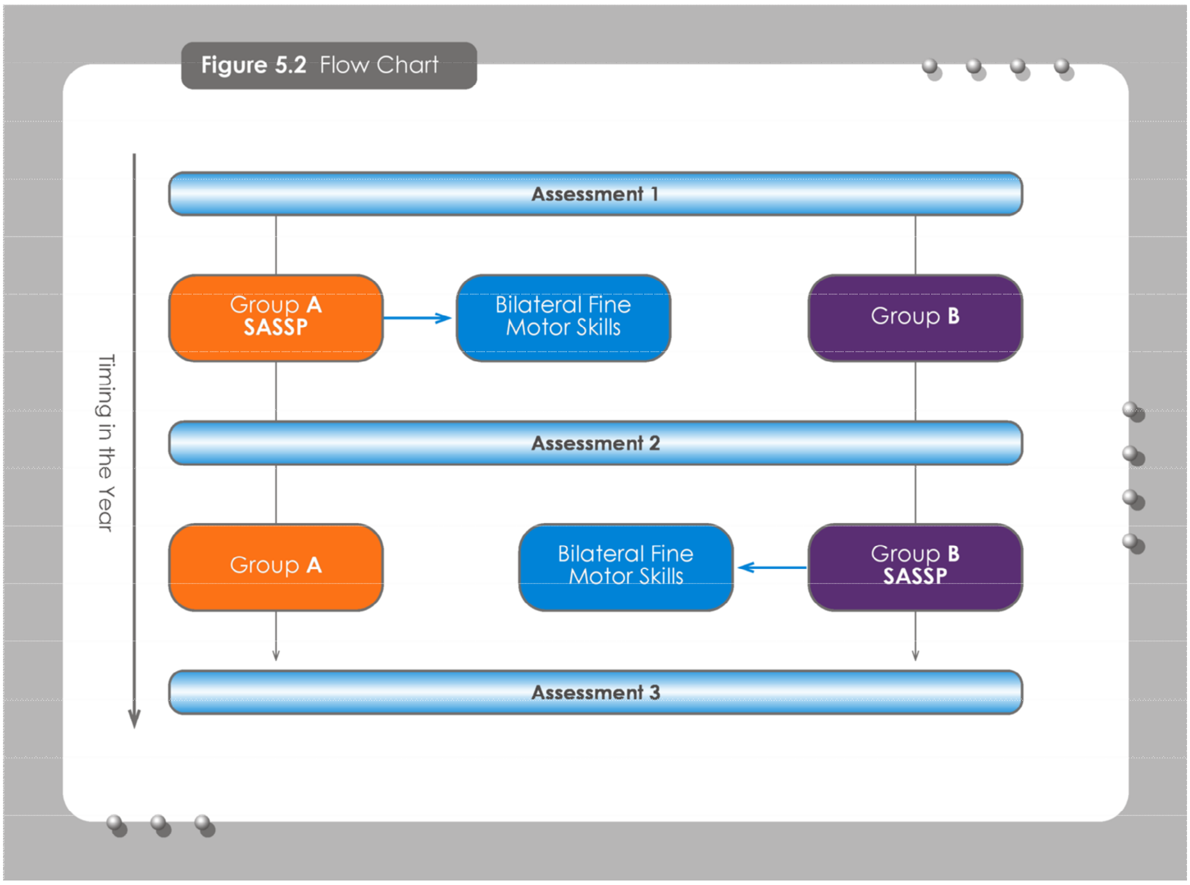


Figure 5.2 Flow Chart of Transferability of Skill

A qualitative element was introduced into the study in terms of the teachers' perceptions of the scissors skills program. A questionnaire with closed and open ended questions was used for teachers to evaluate a number of aspects of the

SASSP. The questionnaire allowed them to express their opinions and feelings about the use of the program. (Appendix V)

5.2 Population

The population included Grade 0 learners at schools within the Johannesburg Metro Area. Grade 0 learners in specific classes within the schools were selected, after a sample of schools had been identified.

5.2.1 Sample Selection

5.2.1.1 Selection of the Schools

Schools in the Johannesburg Metro were identified and the areas and the socioeconomic status of areas around the schools established. Stratified sampling was used to ensure that schools from a high socioeconomic area, a middle socioeconomic area and a low socioeconomic area were selected.
Private schools, provincial fee paying schools and provincial non fee paying schools were identified according to the Gauteng Department of Education's lists of schools. (102, 103, 103, 104)
Convenience sampling was then used to select three schools, in order to cover the identified socioeconomic areas and thus identify a sample of underprivileged children, privileged children as well as a mixed representation.

5.2.1.2 Selection of Grade 0 Classes

Two groups of Grade 0 children per school were required for the study, that is, Group A and Group B. Placement of children into the two groups was based on the existing Grade 0 classes found at each school. The researcher had no involvement in the selection of the two Grade 0 classes.

Out of the 3 schools chosen for the study, 2 schools only had 2 Grade 0 classes and thus both classes were included in the study. The third school had 7 Grade 0 classes and the principal chose 2 that would be able to participate. The distribution of children among the 7 Grade 0 classes was similar in terms of age, gender and socio-economic status. As mentioned, this distribution had taken place before commencement of the study and thus did not influence the selection of the 2 classes.

5.2.1.3 Selection of the Children

It was expected that the age of the children in general would be similar and that most of them would be born in the year 2000. Children generally turn six in their Grade 0 year. This, however, was not the case. The following table shows the age ranges of the children who participated in the study.

Table 5.1 Age Ranges for Participants at the first Assessment

School	1		2		3	
Socio-economic Status	Mixed		High		Low	
Group	A	B	A	B	A	B
Age Range	5;3-6;2	5;4-6;2	5;5-6;4	5;5-6;4	4;4-6;2	4;4-5;10
Mean Age	5;8	5;6	5;10	5;11	5;3	4;11
Born in 2000	21	23	22	23	38	5
Born in 2001	-	-	-	-	-	17
Born in 2002	-	-	-	-	-	18

Ages were calculated from the date of birth to the initial assessment date. Children who were born after 2001 (in School 3B) were excluded from the assessment, thus the mean for 3B did not include any children born in 2002. Otherwise all children in each of the classes were included in the sample. No information was available regarding any physical or visual problems children may have had. Not all schools do screening assessments for these parameters and they could have been present within the sample. However, these variables could not be controlled and all children were included, as this is representative of classroom situations. All the learners in the six Grade 0 classes were therefore approached to participate in the study. During repeated interactions with the children, the researcher was comfortable that there were no subtle neurological problems in the population studied.

5.2.1.4 Selection of the Teachers

All the teachers of the six selected Grade 0 classes were selected to take part in the study.

5.3 Research Procedure

5.3.1 Ethical Considerations

Ethical clearance was obtained from the Ethics Committee for Research on Human Subjects at the University of the Witwatersrand (Clearance Certificate no: M090678). (Appendix W) The principals of the three schools that had been selected were approached and asked if they would be prepared to participate in the study. They all agreed and their schools were included. Telephonic conversations were held with the principals of the schools. The study was discussed in detail and schools were asked to sign permission letters. (Appendix X) Teachers of the six Grade 0 classes were approached to take part in the study and facilitate the implementation of the SASSP in their classrooms over a 10 week period. All the teachers were given an information sheet and signed informed consent having agreed to take part in the study. (Appendix Y)

All parents of children in these Grade 0 classes were given an information sheet and consent form via the teachers (Appendix V) and asked if their children would be able to participate in the study. Parents signed consent forms and also filled out a short questionnaire. (Appendix V) All parents gave their consent and no children in the six Grade 0 classes were excluded from the study. All children were asked for verbal assent with the teacher as a witness before being included in the program.

All parents, teachers and children were made aware that their children's or their own participation was voluntary and their withdrawal from the study could occur at any

time without any consequences to themselves. They were assured of confidentiality and the participants' names, schools and class numbers were kept separate from any data collection sheets that were coded. Only the researcher had access to the participants' names and details for arranging the second and third assessment.
All program booklets collected from the teachers had the names removed and were coded by the researcher on collection.
Feedback was offered to the teachers, parents and schools on request on completion of the project.

5.3.2 Measurement Techniques

5.3.2.1 Task Based Assessment of Bilateral Motor Skills

The task-based assessment (TBA) (Chapter 3) that was developed in the developmental phase of the study was used to collect data by assessing bilateral fine motor skills. All participants were assessed three times using the TBA by the researcher. All results were recorded on the observation sheets.

Scoring of the TBA was done according to three types of measurements:

- Accuracy scores were recorded for tearing and cutting. These were measured after completion of the assessments and were then converted to percentages. The accuracy score was measured in cm; it was the length that the child managed to cut or tear on a line for the items of cutting or tearing. The total length of the line represents 100% and the length of the tearing or cutting that stayed on the line was a percentage of the 100%.

- Point scores for motor components and efficiency used in tasks were recorded. Motor component and efficiency scores were grouped, resulting in one individual score. The child was able to score points for each motor component used in a task and also for the efficiency of the task. The more points scored, the better the approach to the task. (Appendix Q) The motor components that needed to be observed were scored during the assessment; for instance the grip used while writing the name or where the child started drawing while stabilising an object, were scored while the task was executed. Where the quality of the end-product was observed, scores were allocated after the assessment; for instance points for writing the name on a line or the actual line drawn around the object were scored later. Results of the video were also scored after the assessment. This included the observation of the cutting, allowing the tape to be viewed several times if necessary to score the scissor grip, cutting motion and cutting approach.

- Time scores, indicating how fast the items were completed were recorded. This was done during the actual assessment. In order for the time score to be seen as a positive score, i.e. the higher the score the better the result. The scores were converted by subtracting the seconds that it took to complete the task from 180 seconds. Thus if a task took 10 seconds, the score would be converted to 180s – 10s = 170s.

All scores were captured separately and added to a total score for each task. Thus there was a total score for each of the assessment items, namely name writing, drawing around an object, tearing, threading beads, cutting (scissor grip, cutting motion, cutting approach, cutting accuracy, cutting time), tying shoelaces and buttoning.

5.3.3 Scissor Skills Section of the Task Based Assessment

The task of ‘cutting’ was further divided into scissor grip, cutting motion, cutting approach, cutting accuracy and cutting time. As the SASSP was aimed at improvement of accuracy (end-product), as well as approach (execution), these individual scores were kept separate in the data analysis. This would allow for a clearer understanding of which parts of the cutting process actually improved. In each of the assessments, these cutting components were scored separately. (Appendix Q)

5.3.4 Parent Questionnaire

The parent questionnaire was designed to gain some insight into the home environments of the participants from an activity perspective. Not only the school environment has an effect on skill development, but the home environment as well, and thus it was important to include this aspect in the study. Five of the seven questions were designed to be answered by placing a mark on one of the choices. One question required a listing of activities and one question required an estimate of time spent with their child.

Questions were related to the child's previous experience in nursery school, thus indicating some form of input by a qualified teacher. Further, questions relating to afternoon activities and caregivers in the home were asked. This indicated an exposure to other skill developing activities, such as swimming, pottery or ballet etc. Further, it also indicated if the child was in contact with a parent after school, or attended after-care. Questions relating to employment gave an idea of the socioeconomic status of the families, time for their children, as well as single parents present in this sample. Lastly, the availability of fine motor resources such as colouring pencils, scissors, play dough etc was established. Availability of resources probably means exposure to them, thus increasing the possibility of skill development, if used. (Appendix V)

5.3.5 Scoring of Completed Practice and Picture Samples from the SASSP

The program consisted of two aspects, namely the practice and the picture component. These were measured separately.

- Practice samples of the program were collected and were evaluated by allocating a percentage score, depending how accurate the cutting was. This was done by estimating the accuracy. The whole length of the lines on the practice sheet corresponded to 100%. The total length where the participant was able to cut on the line was estimated as a percentage score of these 100%. If a participant cut accurately on half of the lines, s/he scored 50%, if s/he cut accurately only on a quarter of the lines, the score was 25%. (Appendix Z)

- Cut out pictures were pasted into the books and were collected at the end of the program, for evaluation by the researcher. Each picture was scored according to the accuracy with which the pictures were cut out. Each picture had a maximum score, which was based on the number of changes in direction. Thus for each change in direction, the child was able to score another point, if cutting accurately on the line. A square for instance would have a maximum score of 4, which when converted would be 100%. (Appendix AA)

Although the participants were assessed individually by the researcher, where a score for cutting the square and the circle were obtained, the evaluation of the practice and picture components was necessary for the evaluation of the SASSP itself. These scores themselves gave an indication of the level of difficulty of the program and expectations of Grade 0 children in their accuracy.

5.4 Research Procedure and Data Collection

The overall research study outline was as follows:

- All participants were tested at the first assessment date.
- Teachers were trained in the implementation of the scissor skills program.
- Grade 0 classes were allocated as either Group A or Group B in each school.
- Participants from Group A of each school then followed the scissor skills program in the classroom.
- All participants were assessed for the second time.
- Participants from Group B of each school then followed the scissor skills program in the classroom.
- All participants were assessed for the third time.

5.4.1 Assessments

The TBA (Chapter 3) was used for all assessments of the participants' bilateral fine motor skills.

5.4.1.1 Assessment Dates

The assessment dates were organised with the principals.

Table 5.2 Assessment Timetable

	School 1	School 2	School 3
Assessment 1	March	May	March
Assessment 2	June	July	June
Extra Assessment	N/A	N/A	August – Group A
Assessment 3	September	November	September

The assessments dates throughout the year were not constant due to different holiday schedules. School 1 and 3 had four terms, whereas School 2 had three terms and thus the assessments had to be adjusted.

Three assessments were planned for this study. On completion of the second assessment at School 3, the researcher planned to collect the program books as well as the practice components. This, however, was not possible, as the SASSP had not been completed and the teacher had only managed to work up to page 26 of the program. It was thus decided to extend the time for that particular class by three weeks after the July holidays and the teacher was urged to complete the SASSP. Thus, another extra assessment date had to be added for School 3. Therefore Group A in School 3 was re-assessed in August as well as having been assessed in June as planned. The assessment scores recorded in June for this group were replaced with those recorded in August for those participants that were present. Only 21 participants were present in August and thus those scores replaced the June scores. For the other participants that were absent in August, the June scores were used.

One of the limitations of this study was this inability to ensure that the SASSP was completed. By collecting the picture books and the practice components, it became

apparent that not all of the SASSP had been completed in School 3 and it also gave some insight into the quality of work in the classroom.
Another limitation of the study is absenteeism of participants within the schools. This was particularly apparent in School 3, where the teacher also mentioned that participants do not attend school if it is particularly cold (as it was in August). Thus participants missed out on class work, including the SASSP.

5.4.1.2 Assessment Set-up

The researcher asked permission for a separate room for testing at each school, so that the class routine would not be disturbed and also that participants could focus on the assessments. At the same time, however, participants should not be anxious, which can affect their performance. Thus the teacher was asked to send two participants to the assessment, one participating and the other observing the task. When the first child had completed the assessment, this child went back to the classroom, to send the next child to the assessment room. The new child then was able to observe the tasks first, before doing them as well. The participants who were observing the tasks were seated behind the participating child, so that this child was not visually distracted. On completion of the assessment, each child was thanked and s/he was allowed to choose a star as reward.

All schools had the same seating arrangements for the assessment:
The child was seated at a table and the researcher was at 90 degrees to the right of the child. All assessment equipment was placed behind the researcher, so the child was not distracted by it. Only the task that was being done was placed on the table in front of the child. The researcher marked with masking tape on the floor where to kneel in order to video the participants while cutting. All assessment equipment (clutch pencil, drawing-around-bowl, beads and thread, tearing paper, flat plastic shoe with lace, shirt, right- and left-handed scissors and observation sheets) was standard and was used for each child over all of the assessments.

Allocation of number per child:

This was the same in all schools. The principals decided which class should be assessed first. This was arranged with the teachers. Each teacher forwarded a class list, with the names and date of birth of all of the participants. The order of the assessment within each class was left for the teacher to decide. As each child arrived for the assessment, their name was changed to a number on the list and this number was used on the assessment sheet.

School 1 was the first to be assessed. This school made available a store / music room for the assessments. There were several tables and chairs available to set up the assessment. All of these had the right height for Grade 0 participants. The assessment was disturbed on several occasions, while staff was collecting equipment from the room. Here, the researcher waited for them to leave the room before starting the next item on the assessment. All of the participants were assessed within two days.

School 3 was the second to be assessed. This school made available the staff room, which was empty the entire morning. There were two tables and four chairs available for the assessment. The height of the tables and one of the chairs was the correct height for Grade 0 participants. The table surface was uneven; thus for the task of writing the name and drawing around an object, an extra assessment sheet was placed underneath the paper to even this out. Members of staff occasionally entered the room, however, this was a big room and thus at times, participants were not even aware that someone had entered the room. All of the participants were assessed within three and a half days.

Difficulties experienced in this school included the following:

- Class lists were incomplete and not all birth dates were present.
- English was very limited and it was not easy to communicate with many of the participants. This can also increase anxiety levels in the participants, as one is not able to make them feel at ease by talking to them. The method of observing the task before doing it was very helpful here, as participants already knew what was expected in the tasks.

- The teachers often sent more than the required number of participants (two), resulting in some waiting in front of the staff room for their turn. These participants did not want to go back to their classrooms and return later, possibly fearing that they may miss their turn.

School 2 was assessed later than the other two schools, due to their different holiday schedule. This school had a Grade 0 library room that was made available. There were several tables and chairs with the correct height available in the room. There were no disturbances at all throughout all of the assessments. All participants were tested within two days.

5.4.2 Teacher Training

Each teacher was given a 'teacher instruction sheet' (Appendix S and T). Each of the headings on this sheet was discussed with the teachers individually. The scissor grip as well as cutting motion was shown with a pair of scissors and page 1 of the SASSP. Positioning and movement of the stabilising hand was also shown; this was done with the pattern of 'Top and bottom circles joined in a pattern'.
Individual questions were answered.

5.4.3 Division of the Groups

The Grade 0 classes were then divided by the principal of each school so that one Grade 0 class became Group A and the other class became Group B. This was necessary as the timing of the program in the classes has to fit in with the school program. This also eliminated bias on part of the researcher, as the classes were grouped by principals who were unaware of the results of the initial assessments.

5.4.4 Implementation of the South African Scissor Skills Program

Group A would receive the SASSP in the first 10 weeks after the 1st assessment and it would be implemented with Group B after the 2nd assessment, in the later part of the year. Each teacher carried out the program at the time allocated to her by the principal of the schools.

The correct amount of right- and left-handed scissors were purchased and given to the teachers for use in the SASSP and to keep thereafter. At the end of the SASSP, School 2 did not want to keep these scissors, as all participants have their own scissors; scissors from School 2 were thus donated to School 3.

All six teachers received the SASSP for each child in the correct order of presentation. Further, plastic sleeves with participants' names were provided for collection of some samples of the practice component. (Appendix Z) Logistically, only the initial page of each practice component could be collected from each school. This was a limitation in the evaluation of the practice component, as only patterns with 3mm line thickness were collected. However, it gave an indication of the participant's cutting skills and their ability to cut new patterns.

All participants received their own A5 picture books with blank pages and glue sticks, in order to collect and paste the pictures. (Appendix AA) These were collected at the end of the program, for evaluation by the researcher. Once evaluated, they were returned to the schools, so that the participants could take the books home.

The SASSP was implemented in Group A and Group B in different stages within that Grade 0 year. Most participants in School 1 and School 2 participated in all of the picture and practice components. This was not the case in School 3, where only some of the picture and practice components were returned. Here, the SASSP was not completed or not all work was handed in.

5.4.5 Loss to Follow up

The following table summarises the number of participants seen at each assessment.

Table 5.3 Assessment Number

	School 1		School 2		School 3	
Groups	**Group A**	**Group B**	**Group A**	**Group B**	**Group A**	**Group B**
Assessment 1	21	23	22	23	38	22
Assessment 2	21	21	21	23	35	22
Extra Assessment	N/A	N/A	N/A	N/A	21	N/A
Assessment 3	21	20	22	23	27	19
Loss to Follow up	0	3	0	0	11	3
%	0	14	0	0	28	13

There was a small percentage loss to follow up over the three assessments in Schools 1 and 2 mostly due to a participant being absent on a given day due to illness. Loss to follow up in School 3 was much greater for Group A. This was discussed with the teacher, who said that this was generally a problem in her class. Participants were absent due to weather, transport or circumstance at home. Illness was another reason; however, the teacher was only informed once the child returned to school. When wanting to phone parents to urge them to bring their participants for the assessment in August, no telephone numbers were available, as they had not been recorded. At the third assessment, many participants had gone on holiday already. These participants did also not return when school started after the holiday, but returned later.

This was not such a big problem in Group B of School 3. This teacher mentioned that many participants in her class had nowhere else to go in the mornings and thus attended school more regularly.

The following table is a summary of pictures and practice components that were collected. It should be mentioned that not all of these were complete sets, especially in School 3. Only those, where at least half of the pictures or practice components were returned were evaluated. Thus, loss to follow up occurred mainly in School 3.

Table 5.4 Number of Practice Components and Picture Books

	School 1		School 2		School 3	
Groups	**Group A**	**Group B**	**Group A**	**Group B**	**Group A**	**Group B**
No. of participants	21	23	22	23	38	22
Picture Books returned	21	23	22	23	30	8
Loss to Follow up	0	0	0	0	8	14
%	0	0	0	0	21	63
Practice sections returned	20	23	20	23	28	10
Loss to Follow up	1	0	2	0	10	12
%	5	0	9	0	26	54

5.5 Analysis of Data

Professor Piet J Becker (MSc (Pret) PhD (Unisa)) of the Biostatistics Unit, Medical Research Council, South Africa and School for Therapeutic Sciences, University of the Witwatersrand, South Africa assisted with the data analysis. The following program was used: StataCorp. 2003. Stata Statistical Software: Release 8.0. College Station. TX: Stata Corporation.

Scissor skills and all other bilateral skills were assessed in each of the three assessments. The following methods were used:

5.5.1 Demographics of the sample

Descriptive statistics were used to analyse the demographics of the sample. The parent questionnaire was analysed by using percentages of the total questionnaires filled in per group.

5.5.2 Change in Scissor Skills

The participants were divided into two groups, Group A and Group B. The groups were assessed before and after participating in the SASSP, to establish the change in participants' scores for scissor skills.

Changes for each participant in a group will be established by comparing the three scores for scissor grip, cutting motion, cutting approach, cutting accuracy and cutting time over the year.

Changes in Group A were compared to changes in Group B after Group A had received the intervention and Group B had not yet received intervention. Changes in both groups were then compared when Group B had received the intervention and Group A had no further intervention.

Changes in Group B were also measured before intervention, between assessment 1 and assessment 2, to establish development of skills without a dedicated class program.

ANOVA scores were used as a statistical measure of cutting accuracy. Median percentile ranks are used in standardised tests and tests of achievement and proficiency reports in the education system compare individuals, classes and schools in terms of percentiles. Thus this method of comparison was used for cutting accuracy looking at the square and the circle separately, to allow comparative data in terms of the participants' ability relative for each school to be established. The median is a measurement of central tendency, as is the mean. However, if two central tendencies are reported, one can identify the skewness of the data distribution. If the distribution is skewed, then the use of medians of percentiles is an appropriate method to indicate variability. (101) Further, descriptive percentage evaluation was used with mean percentage scores and standard deviation scores for five aspects of scissors skills, to establish in which of these skills differences occurred during the intervention. Lastly, confidence intervals, determining statistically significant changes after intervention were used to measure the effect of the intervention on the five aspects of scissor skills. (105) These were used in preference to t tests because clinical research tends to use confidence intervals more often than point estimates. The confidence interval is a range of scores within which the population mean is expected to fall. (101) If using a standard statistical test only, the conclusion one reaches when the result is of 'no statistical significance', is that the current evidence is not strong enough. This does not mean that there is no change; it means that the change is not evident enough. Thus, when using confidence intervals, it allows the researcher to establish clinical differences, even though they may be seen as falling within the range of scientific indifference. (101)

5.5.3 Retention of Skill

Group A was assessed in October/November, three months after the completion of the intervention phase of the program, to establish whether skill retention had occurred after no further intervention was given in that period. Skill retention for Group A was defined as a less than 10% decrease in their score when compared to their previous score obtained at the end of the intervention program in June. If this percentage is used a sample of 24 will have a power of 90% for statistical significance (when a standard deviation of 14.1 or less is assumed.)

Here again, percentile ranks, descriptive percentage evaluation and also confidence intervals were used.

5.5.4 Changes in Scissor Skills dependent on the Time of Implementation of the SASSP

A change in scissor skills in the groups was established depending on whether the intervention was presented in the first or second 10 weeks in the study. Thus the change of Group A (comparison of assessment 1 and assessment 2) was compared to the change in Group B (comparison of assessment 2 and assessment 3).

The analysis of covariance was employed to assess differences between the two groups, with respect to change from baseline scores established in March to those after the period of intervention, where the baseline was also a covariate.

Descriptive mean percentages with standard deviations, as well as confidence intervals, were used to analyse data in terms of the five aspects of scissor skills to establish whether different aspects improved at different times in the year.

5.5.5 Equivalence

Equivalence to establish whether participants were able to close the gap in scissor skills deficits, which existed on the initial assessment in March after the program was completed, was calculated.

Privileged and underprivileged participants could be considered equivalent at the end of the study, if the scores of the underprivileged participants from the school in the low socioeconomic area, are less than 10% lower than the scores of the participants from the school in the high socioeconomic area. A sample of 24 per group will have 90% power to detect significant equivalence. Equivalence will be assessed using a 95% confidence interval and groups will be regarded equivalent if the lower limit does not exceed 10%.

Descriptive mean percentages and confidence intervals were used to analyse the data.

5.5.6 Transferability of fine motor skills

Transferability of fine motor skills was assessed; only cutting skills were implemented in the SASSP, yet a variety of other bilateral fine motor skills were assessed on three occasions. The transfer of scissor skills to the other bilateral skills was thus evaluated.

This was established by evaluating the improvement in each item of the task performance test for bilateral fine motor skills after that group had received the SASSP. Thus, change in bilateral tasks for Group A was noted from assessment 1 to assessment 2 and change in bilateral tasks for Group B was noted from assessment 2 to assessment 3. Descriptive mean percentages and confidence intervals were used to analyse the data and establish if any significant changes occurred over the period of the study.

5.5.7 Maturation of skill

The scissor skills scores of Group B on the 2nd assessment were compared to the baseline (1st) assessment, to establish what changes in skill had occurred after a 10 week period in Grade 0 before the intervention program was implemented. This could be attributed to natural maturation and environmental stimulation from school and/or home involvement. Further, change in the other bilateral assessment items including name writing, drawing around an object, tearing, threading, tying shoelaces and buttoning were compared in all three assessments, in Group A and also Group B. Descriptive mean percentages and confidence intervals were used to analyse the data. ANOVA scores were used as a statistical measure of bilateral skills.

5.5.8 Program evaluation

Picture and practice components were evaluated. Mean percentages were used to evaluate the level of difficulty of the program and the ability of the participants to carry out the individual tasks. Practice and picture components were compared, in order to establish if they were completed with similar accuracy.

5.5.9 Teachers perceptions of the program

Coding and themed analysis was used to analyse the questionnaires filled out by the teachers as well as the verbal feedback received from them.

6. RESULTS – CHAPTER 6

This study consisted of an initial assessment of bilateral fine motor skills of Grade 0 participants at three different schools, used as a baseline for comparison to an intervention using a scissor skills program. Group A of each school then participated in the scissor skills program over a ten week period. Following this, all participants were re-assessed, after which Group B of each school took part in the 10 week scissor skills program. All participants were then re-assessed for a third time.

The results of this study are presented in four main parts:

1. Changes in scissor skills were measured, including the comparison between three schools from areas of varying socio-economic statuses to assess the skills in the context of South African urban schools. Scissor skills, in Grade 0 children, were therefore analysed, to establish the equivalence between the Grade 0 children in the three schools. The assessment covered aspects such as the change in various aspects of scissor skills, skill retention and the effect of presenting an intervention program at different times in the year.
2. The assessment results of the participants' bilateral fine motor skills were analysed in terms of the intervention with a scissor skills program to establish transferability of fine motor skills during the intervention period. The normal development of these skills during the period of no intervention was also assessed.
3. The scissor skills program was evaluated. The program evaluation covered aspects of the practice as well as the picture components.
4. Further, the teacher's perceptions of the program as well as the results of the parents' questionnaire were documented.

6.1 Demographics

6.1.1 Demographics of the schools

The three schools used in the study were situated in the Johannesburg area, Gauteng, South Africa. School 1 was representative of a school with mixed socio-economic backgrounds (a fee paying public school where some children are exempt from paying fees). School 2 was representative of a school with high socio-economic backgrounds (a private school) and School 3 with low socio-economic backgrounds (a non-fee paying school). The classroom size was fairly equal amongst all of the schools. In terms of facilities and space there was less space for scholars in the classroom in School 3, as each class had greater numbers than the other schools. (Table 5.1)

School 2 had special facilities within the class such as a reading corner, a playing corner, table and chairs of correct height and a carpeted area for ring time. School 1 had similar facilities, although the quality did not quite match those of School 2. School 3 also had tables and chairs for the children; however, these were in poor condition with many backrests of chairs broken and table surfaces uneven. These children were also seated closer together, thus having less space on the table available to them individually.

In winter, School 3 was exceptionally cold in the classrooms and only one heater was available. This was not adequate, as the windows did not shut properly, resulting in a draft in the room. Many children stayed home on cold days and this resulted in many children not being present in winter when the second intervention period occurred. (Table 5.1)

All three schools had resources available within the classes. However, School 2 had the most variety and best quality. School 1 had equipment which was well looked after and neat. In School 3 there were a few books and some pegboards and games. These were generally in a poor condition, being dirty and with parts missing. The overall impression of School 3 was an untidy appearance within the classrooms, with papers stacked on open shelves.

Qualification of the teachers varied at the different schools. One teacher at School 1 did a National Certification at UNISA. The other did a 3 year Nursery School

Education at JCE. In School 2, both teachers were Grade R teachers, fully qualified as Foundation Phase teachers with particular emphasis on Pre-Primary teaching. Their policy is that all teachers must have a 4 year qualification. Qualification of teachers was not divulged at School 3.

6.1.2 Demographics of the participants

Demographics of the participants in terms of age were presented in Chapter 5 as the age was used as an inclusion or exclusion criteria.
The gender distribution of the sample appears in Table 6.1

Table 6.1 Distribution of Male and Female Participants

School		**1**		**2**		**3**	
Group		A	B	A	B	A	B
Gender Ass 1	Female n	8	13	9	10	18	7
	Male n	13	10	13	13	20	15
Gender Ass 2	Female n	8	12	8	10	18	7
	Male n	13	9	13	13	17	15
Gender Ass 3	Female n	8	11	9	10	13	7
	Male n	13	9	13	13	14	12
Total Ass	Female n	38.1%	56.43%	40%	43.5%	49%	15.9%
	Male n	61.9%	43.75%	60%	56.5%	51%	84.1%
Total Ass	Female n	47.1%		41.75%		32.45%	
	Male n	52.9%		58.25%		67.55%	

There was no statistically significant difference on Chi squared test between the males and females in the study ($p=0.08$). In total, the schools had a greater number of males. Results were analysed together, as children are taught in groups with both males and females present in classrooms.

6.1.3 Parent Questionnaires

Parents were asked to fill out a short questionnaire (Appendix V). The questionnaire gave some insight into participants' home environments in terms of skill exposure and development. Parents were asked if the participants had attended nursery school. Further, questions were asked regarding extra murals as well as creative materials that are present and for use by participants in the home environment.

The questionnaire gave some insight into home circumstances of these participants from different socio-economic backgrounds. Not all questionnaires were completed; however, it was possible to see a different trend over the 3 schools, representing the different socio-economic environments.

Table 6.2 Parent Questionnaire

	School 1	**School 2**	**School 3**
Questionnaires returned	44	39	57
Nursery School attendance	89%	100%	66%
Aftercare attendance	45%	5%	0%
Working Father, full-time	86%	92%	40%
Working Mother, full-time	86%	13%	30%
Father present at home	86%	100%	70%
Extra Murals	45%	100%	0%
Materials at home			
Colouring pencils	100%	100%	68%
Paintbrush and paint	73%	90%	11%
Paper	100%	97%	84%
Beads	32%	67%	14%
Scissors	98%	100%	82%
Felt tip pens	86%	97%	51%
Playdough	66%	85%	19%

Table 6.2. illustrates that participants from School 2 had home environments, where the family is intact, where both father and mother are present, where the father generally works full-time and the mother is at home to care for the children. All of these children have been to nursery school, indicating, that they have profited from input from trained professionals. The children from School 2 also had the most resources at home, available to them. These are trends that affect skill development in young children. (Appendix BB).

6.2 Changes in the Scissor Skills

The initial assessment of scissor skills which was included in the overall fine motor skills test (TBA) was used as a baseline, against which other assessment results were compared. The change in scissor skills over time between the three schools was analysed when an intervention period had been used to address this skill. The changes after intervention with a period of no intervention were considered, to establish skill retention. Further, the timing of presenting the scissor skills program at different times within the year was also analysed. Lastly, the equivalence in scissor skills between the Grade 0 children in three schools in varying socio-economic areas was considered.

6.2.1 Comparison of Percentile Scores for Accuracy of Cutting before and after Intervention

Results of change in terms of scissor skills were evaluated according to descriptive percentages. Medians of percentiles were used only for change in terms of cutting accuracy for both the circle and the square before and after intervention with the SASSP. This allowed for the comparison of the level of ability at the schools. (Appendix CC) Thus only assessment 1 and 2 for Group A and assessment 2 and 3 for Group B were shown in Table 6.3, as these were the scores obtained immediately before and after the intervention.

A median rather than a mean is used to evaluate medians of percentiles, as this is a comparative value for these specific participants, which does not take the actual scores into account. (60) In this study the median thus indicates a shift in participants scoring in a given Group A or B, placing their ability on a comparable level to the participants in the other groups and schools. Table 6.3 shows the median for each group in the three schools.

Table 6.3 Medians of percentiles of Group A and B for all Schools before and after Intervention

School 1	**Group A**			**Group B**		
Cutting Accuracy	**Ass 1**	**Ass 2**	***Change***	**Ass 2**	**Ass 3**	***Change***
Square	86	100	*4*	90	96	*6*
Circle	62	91	*29*	67	80	*13*
School 2	**Group A**			**Group B**		
Cutting Accuracy	**Ass 1**	**Ass 2**	***Change***	**Ass 2**	**Ass 3**	***Change***
Square	87	96	*9*	100	100	*0*
Circle	81	88	*7*	91	100	*9*
School 3	**Group A**			**Group B**		
Cutting Accuracy	**Ass 1**	**Ass 2**	***Change***	**Ass 2**	**Ass 3**	***Change***
Square	9	94	*85*	29	78	*49*
Circle	9	84	*75*	14	72	*58*

The results in Table 6.3 for cutting out the square indicate that the participants at both School 1 and School 2 were above the 75th percentile on the initial assessment and retained this, moving up to between the 96th and 100th percentile after intervention. The first assessment for School 2 was in May, showing that the participants had had almost half a year to develop skills already.

School 3 lagged behind with the participants cutting skill being between the 9th and 29th percentile initially. They improved to above the 75th percentile after intervention. The circle was the more complex shape to cut out, with the level of ability of participants at School 1 falling between the 50th and 75th percentile and those at School 3 lagging far behind at baseline (9th - 14th percentile).
At baseline, only participants at School 2 achieved above the 75th percentile for cutting out a circle. Although participants at School 1 and also Group A in School 3 achieved this level after intervention, participants in Group B at School 3 still fell just below the 75th percentile after intervention.
The greatest increase in medians of percentiles occurred in Group A and Group B for School 3. This change took place directly after the intervention and indicates a great improvement in skill within those classrooms.

The following figure is a graphic presentation of the change in median scores of the medians of percentiles over the three assessments for Group A and B at the three schools.

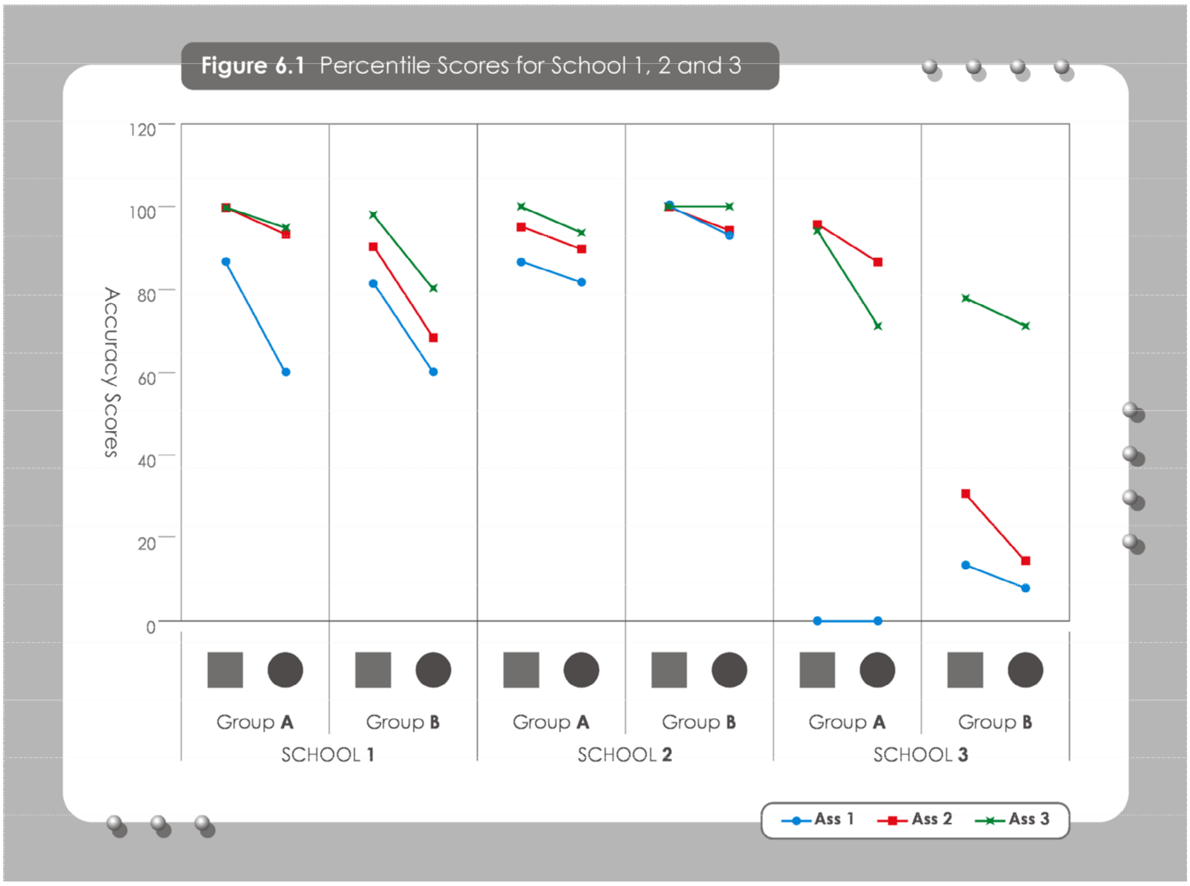


Figure 6.1 Percentile Scores for School 1, 2 and 3

Figure 6.1 indicates the change in median scores of the medians of percentiles over the three assessments for Group A and B at the three schools.

It can be seen that the circle always scored lower for all groups. There was little change in skill for Group B between assessment 1 and 2, where there was no intervention but where participants were involved in the traditional Grade 0 program. The significant change between assessment 1 and 2 in School 3A as well as between assessment 2 and 3 in School 3B is evident.

6.2.1.1 Changes in Scissor grip, Cutting motion, Cutting approach, Cutting accuracy and Cutting time before and after Intervention

For percentage evaluation, each group was evaluated individually over the three assessments, comparing scores before and after the intervention. Thus for Group A, assessment 1 and 2 and for Group B, assessment 2 and 3 were compared as this was the assessment directly before and after the intervention. Since the scissor skill program aimed at improving scissor grip, cutting motion, cutting approach, cutting accuracy and cutting time, each of these aspects were analysed separately. Further, confidence intervals were used to measure the effect of the intervention program.

Table 6.4 Intervention Results

Category	School	Group A					
		Ass 1		Ass 2		1/2	
		x	SD	x	SD	CI	p-value
Scissor Grip	1	83	±11.22	89	6.68	-11.75 to -0.25	**0.05**
	2	79	±13.14	94	9.78	-22.17 to -7.83	**0.05**
	3	73	±12.10	84	12.73	-16.83 to -5.17	**0.05**
Cut Motion	1	51	±14.65	78	15.25	-36.36 to -17.64	**0.05**
	2	58	±16.44	78	10.97	-28.50 to -11.50	**0.05**
	3	41	±15.25	56	18.59	-22.96 to -7.04	**0.05**
Cut Approach	1	58	±11.72	70	11.36	-19.18 to -4.82	**0.05**
	2	63	±11.04	68	15.09	-13.07 to 3.07	**ns**
	3	36	±15.69	54	16.47	-25.47 to -10.53	**0.05**
Cut Accuracy	1	71	±24.94	81	25.28	-25.59 to 5.59	**ns**
	2	79	±19.74	87	17.37	-19.46 to 3.46	**ns**
	3	21	±23.08	76	25.34	-66.20 to -43.80	**0.05**
Cut Time	1	81	±6.18	84	6.86	-7.-7 to 1.07	**ns**
	2	85	±4.30	83	3.07	-0.19 to 4.19	**ns**
	3	72	±13.18	75	11.79	-8.85 to 2.85	**ns**

Significance p≤0.05

ns = not significant

CI = confidence interval

Table 6.4 (continued) Intervention Results

Category	School	Group B					
		Ass 2		Ass 3		2/3	
		x	SD	x	SD	CI	p-value
Scissor Grip	1	88	±7.61	90	5.46	-6.48 to 2.48	**ns**
	2	88	±8.64	91	6.89	-7.79 to 1.79	**ns**
	3	75	±13.75	82	11.18	-15.05 to 1.05	**ns**
Cut Motion	1	60	±17.18	75	14.29	-24.87 to -5.13	**0.05**
	2	67	±16.38	76	14.36	-17.93 to -0.07	**0.05**
	3	43	±16.87	70	17.39	-37.77 to -16.23	**0.05**
Cut Approach	1	59	±10.06	67	9.91	-14.32 to -1.68	**0.05**
	2	66	±13.61	76	13.40	-18.03 to -1.97	**0.05**
	3	41	±19.50	57	13.98	-26.69 to -5.31	**0.05**
Cut Accuracy	1	68	±24.77	83	17.32	-28.57 to -1.43	**0.05**
	2	82	±22.78	94	12.76	-23.10 to -0.90	**0.05**
	3	32	±29.62	73	20.08	-57.39 to -24.61	**0.05**
Cut Time	1	85	±3.87	87	5.09	-4.85 to 0.85	**ns**
	2	87	±3.42	86	3.96	-1.10 to 3.10	**ns**
	3	80	±10.38	79	12.18	-5.95 to 7.95	**ns**

Significance $p \leq 0.05$

ns = not significant

CI = confidence interval

In Table 6.4 the confidence intervals indicate statistically significant improvement for a number of aspects in both Group A and B. Scissor grip only improved significantly in Group A in all three schools while cutting motion improved significantly in all groups and all schools. Cutting approach showed statistically significant changes in Group B (all schools), as well as Group A (School 1 and 3). Cutting accuracy showed statistically significant changes in Group B (all schools) and in Group A (School 3). Cutting time did not improve significantly in any school.

Figure 6.2 represents the change in the various aspects of scissor skills after intervention. The initial assessment is used as baseline and is represented as line 0 with the graph showing the change in scissor skills in percentages. The percentage of improvement varied from a few percent to over 50%. The greatest observable change was seen in cutting accuracy (blue) and cutting motion (green).

Figure 6.2 Differences in Scissor Skills Pre and Post Intervention

There was greater improvement in groups at School 3 who had poor initial scores compared to the improvement in School 2 that already had a good skill on the initial assessment.

Cutting Time is described separately, as these results were different from the other aspects. Three Groups (that is half of the groups) showed a slower time on the second assessment. Further, the standard deviation for School 3 (SD = 10.38 to 13.18) was markedly bigger than for School 1 and 2 (SD = 3.87 to 6.86), indicating more fluctuation within the speed of cutting in that school. The range of improvement was between -2% and 3%. This represents -3,6 seconds to 5,4 seconds which is a considerable range in terms of working speed but not significant. ($p=0.378$). 180 seconds represented the total time. A change of 18 seconds therefore represents 10% of the total time. In terms of percentages, this may seem little, however, in terms of working speed, 18 seconds represents a large change, especially if the activity only took 12 seconds for some children to complete. Thus, when looking at time, one needs to look at the change in seconds, rather than the percentages obtained.

6.2.2 Change in Scissor Skills without Intervention

Group B in all three schools only participated in the intervention later in the year. This means, that the participants relied on classroom activities in order to develop their scissor skills. The following table summarises the medians of percentiles for the square and circle over assessments 1 and 2 for Group B at all three schools

Table 6.5 Medians of Percentiles for Group B at all Schools for Assessments 1 and 2

Group B	School 1			School 2			School 3		
Cutting Accuracy	**Ass 1**	**Ass 2**	***Change***	**Ass 1**	**Ass 2**	***Change***	**Ass 1**	**Ass 2**	***Change***
Square	83	90	*7*	100	100	*0*	12	29	*17*
Circle	61	67	*6*	90	91	*1*	8	14	*6*

When looking at scissors skills in the different schools individually there was greatest overall change in medians of percentiles from below the 25^{th} to above the 25^{th} percentile (Table 6.5). This was seen for participants at School 3 in cutting out a square. This school scored a lower baseline mean percentage, thus their improvement was on a very low skill base. Even though the participants in School 3 had the greatest improvement, the normal classroom program did not allow them to improve to the skill level found at baseline in School 1 and 2.

The following graph is a presentation of change in cutting constructs before intervention.

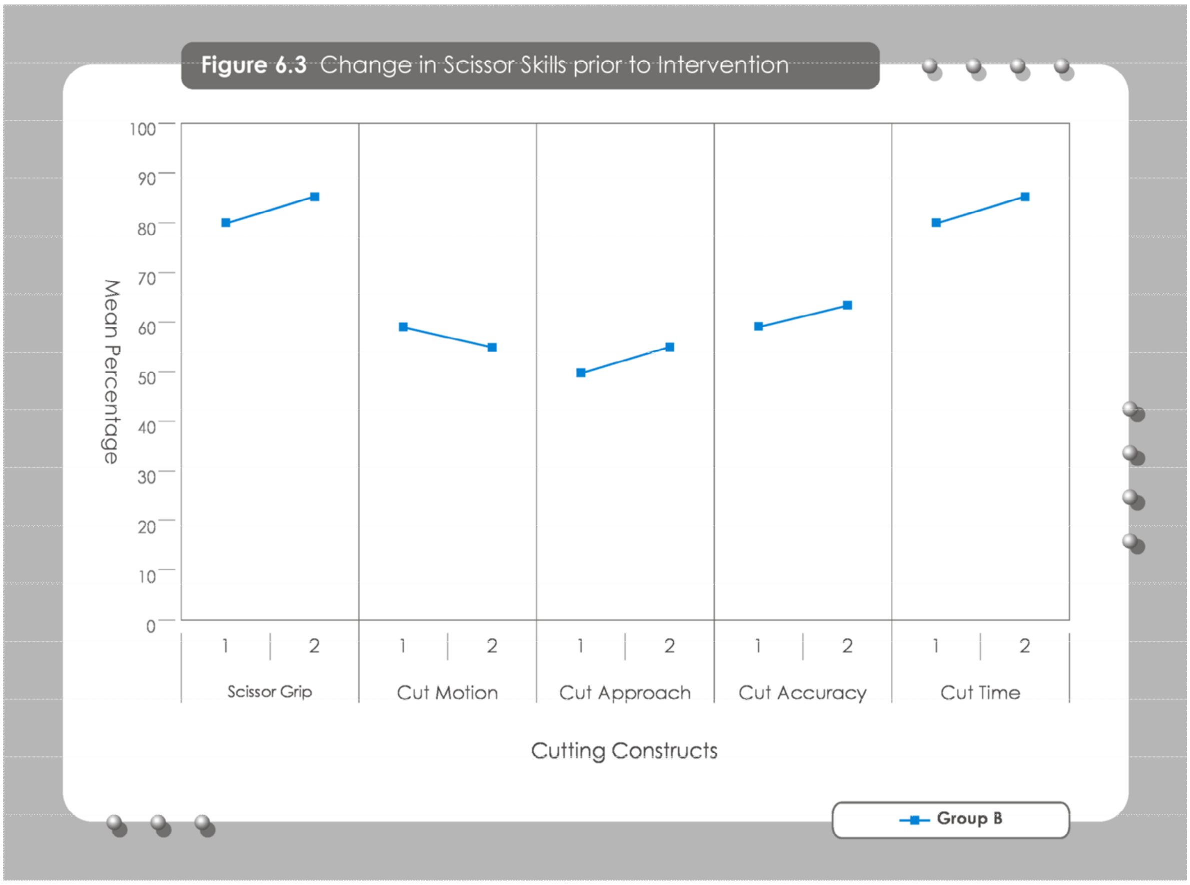


Figure 6.3 Change in Scissor Skills prior to Intervention

In Figure 6.3 we can see the change in the various aspects of the scissor skills between assessment 1 and 2 for Group B of all three schools combined. They had not received the input of the scissor skills program. The general trend is that of slight improvement over all three schools, including the aspects of scissor grip (+2%), cutting approach (+5%), cutting accuracy (+4%) and also cutting time (+4%). Cutting motion deteriorated by 1%. The only improvement above 10% in cutting accuracy (Appendix EE) was seen in School 3.

Table 6.6 Confidence Intervals (CI) for Scissor Skills prior to Intervention

Group B	Scissor Skills prior to Intervention					
Assessment 1/2	School 1		School 2		School 3	
	CI	p-value	CI	p-value	CI	p-value
Grip	-9.20 to 1.20	ns	-6.06 to 4.06	ns	-7.32 to 9.32	ns
Motion	-14.01 to 8.01	ns	-6.51 to 12.51	ns	-9.02 to 15.02	ns
Approach	-13.47 to 1.47	ns	-9.32 to 7.32	ns	-20.22 to 4.22	ns
Accuracy	-17.23 to 13.23	ns	-11.54 to 13.54	ns	-28.13 to 8.13	ns
Time	-11.55 to -0.45	0.05	-7.82 to -2.18	0.05	-7.94 to 3.94	ns

Significance $p \leq 0.05$

ns = not significant

Table 6.6 shows that there was no statistically significant change in scissor grip, cutting motion, cutting approach and cutting accuracy. There was a significant change in School 1 and School 2 for cutting time.

6.2.3 Retention of Scissor Skills

6.2.3.1 Medians of percentiles to establish the comparative position after a period with no intervention

By analysing the medians of percentiles in accuracy of cutting out a circle and a square in the period after the intervention, the retention of this accuracy could be evaluated.

This could be done for Group A only, as these children did the scissor skills program at the beginning of the year. They then had no further intervention between assessment 2 and 3.

Table 6.7 Medians of percentiles for Group A for all Schools at Assessment 2 and 3

Group A	School 1			School 2			School 3		
Cutting Accuracy	Ass 2	Ass 3	*Change*	Ass 2	Ass 3	*Change*	Ass 2	Ass 3	*Change*
Square	100	100	*0*	96	100	*4*	94	92	*-2*
Circle	91	90	*-1*	88	92	*4*	84	73	*-11*

Table 6.7 illustrates that participants from School 2 improved relative to the other two schools. Participants in School 1 almost remained the same, with a very slight

negative trend for cutting the circle. The median, however, was still at the 90th percentile. The accuracy of participants in School 3 decreased relative to the other two schools for both the square and the circle, with the circle dropping below the 75th percentile. Thus they showed much greater initial improvement, however, their accuracy in cutting dropped comparative to these other participants during the period of no intervention.

6.2.3.2 Percentage change in Scissor Skills after a period with no Intervention

The following graph presents skill retention in mean percentage scores. When looking at cutting accuracy, the scores for cutting the square and cutting the circle are combined. School 1 showed an improvement of 7% mean percentage accuracy. However, the SD score decreased from 25,28 to 14,37. For School 2, this was slightly different. Participants scored very similarly in terms of percentage and SD scores over assessment 2 and 3. The participants of School 3, when comparing the percentage scores and SD scores, these remained the same over assessment 2 and 3 for the five aspects of scissor skills.

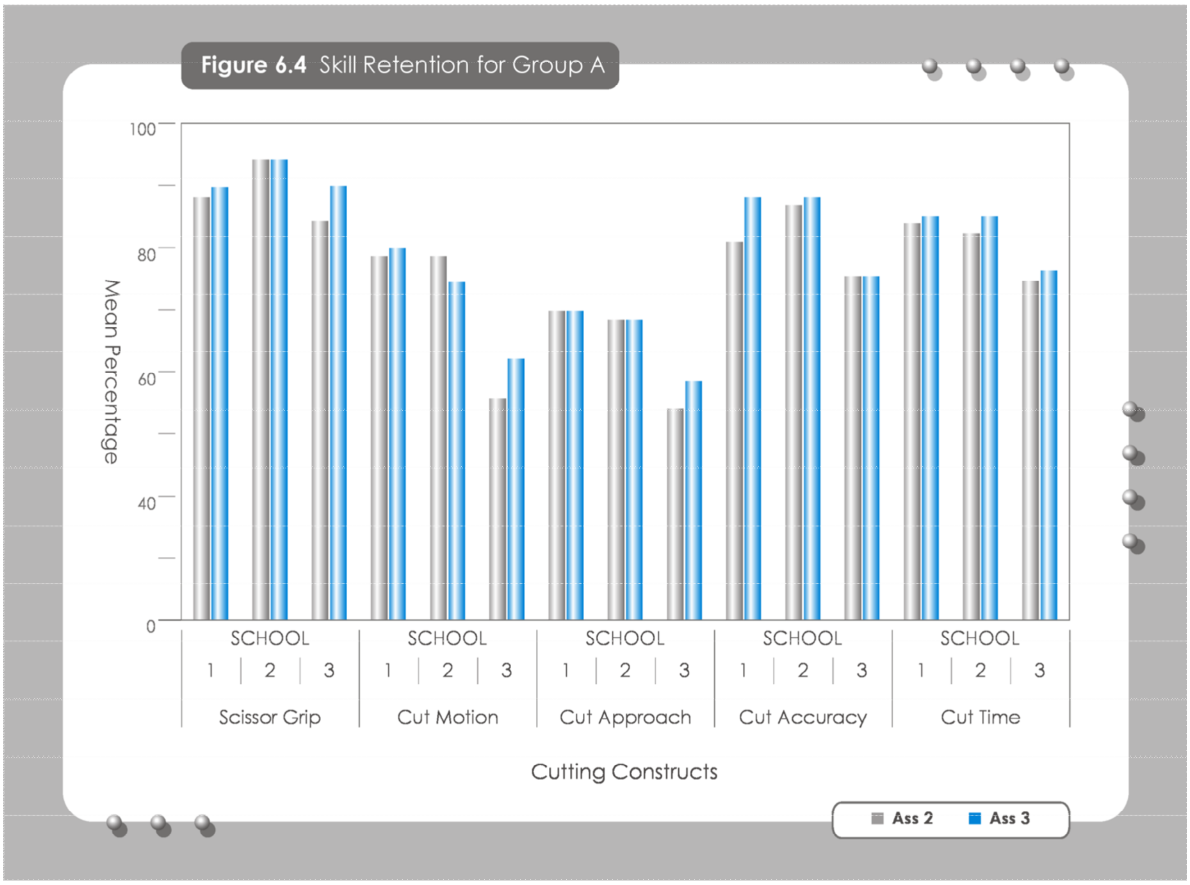


Figure 6.4 Skill Retention for Group A

Figure 6.4 illustrates the mean percentages for the various aspects of the scissor skills scored by Group A at assessment 2 when compared to assessment 3. A higher score on assessment 3 shows improvement from post-program to three months later, without further intervention. (Appendix FF)

The results indicate a maintenance or marginal improvement in skill (ranging from 0 to 7%). There was a slight decrease (-3%) in performance as seen in cutting motion for School 2. This score, however, was still higher than that achieved by School 3. Thus although School 2 did show a slight decrease in skill, the quality was still at an acceptable level. Greatest improvements ranged from 5% to 7%. This was seen mainly for School 3. Scissor grip improved by 6% (School 3), cutting motion by 7% (School 3), cutting approach by 5% (School 3) and cutting accuracy by 7% (School 1).

Table 6.8 Confidence Intervals (CI) for Skill Retention

Retention	Group A					
Assessment 2/3	School 1		School 2		School 3	
	CI	p-value	CI	p-value	CI	p-value
Grip	-5.37 to 3.37	ns	-5.56 to 5.56	ns	-11.86 to -0.14	0.05
Motion	-10.47 to 6.47	ns	-5.87 to 11.87	ns	-15.37 to 1.37	ns
Approach	-6.86 to 6.86	ns	-9.56 to 9.56	ns	-12.20 to 2.20	ns
Accuracy	-19.64 to 5.64	ns	-11.16 to 9.16	ns	-13.26 to 13.26	ns
Time	-4.79 to 2.79	ns	-4.55 to 0.55	ns	-7.20 to 3.20	ns

Significance $p \leq 0.05$

ns = not significant

Confidence intervals results in Table 6.8 show that statistically significant change ($p \leq 0.05$) found in scissor grip for School 3 from post-program to three months later. All other changes were not of statistical significance.

6.2.4 Effect of presenting the program at different times of the year

The amount of change after completing the scissor skills program was measured. Group A was compared between assessment 1 and 2. Group B was compared between assessment 2 and 3. These two groups were then compared to ascertain, which group showed the greater improvement. (Appendix GG)

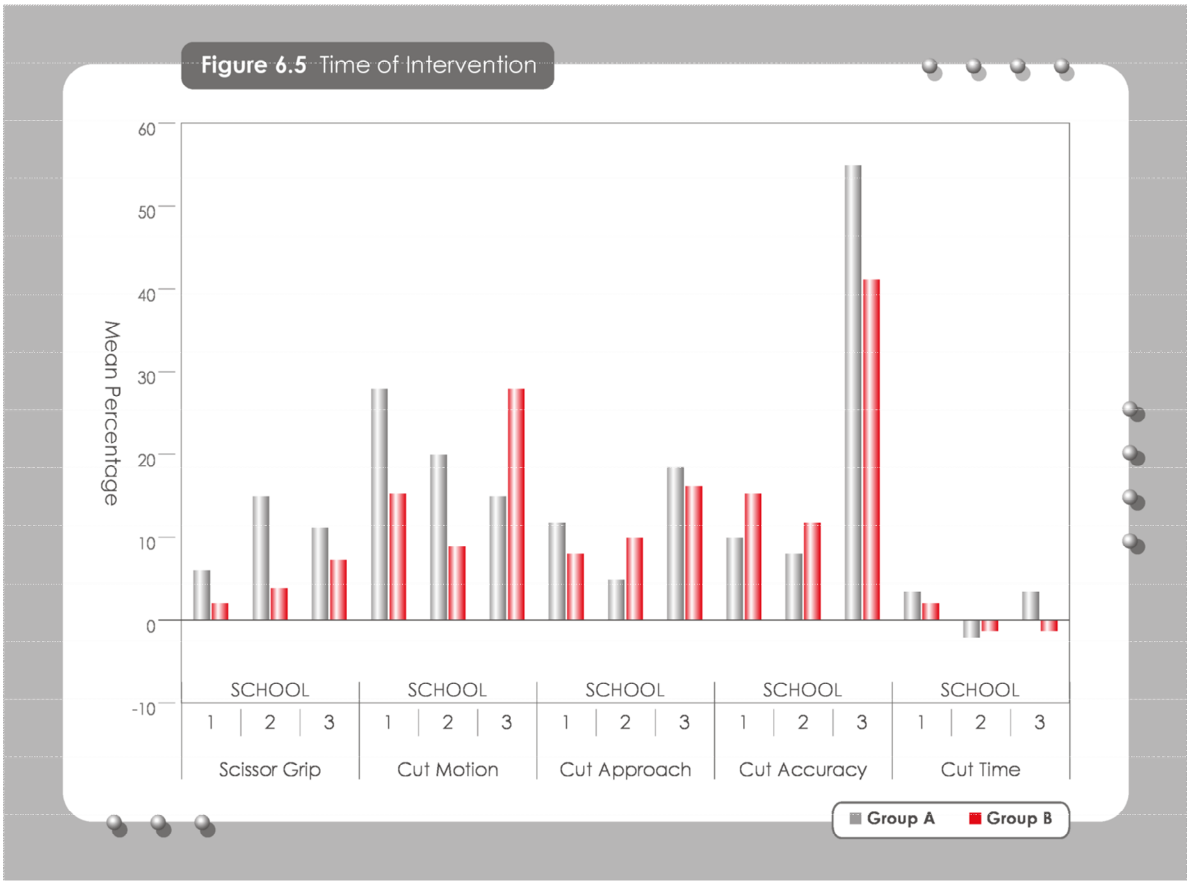


Figure 6.5 Time of Intervention

The baseline of Figure 6.5 is the score achieved by the participants in the assessment prior to the scissor skill program. The coloured bars show the change achieved through the SASSP. Figure 6.5 shows that 66% of the time, there was greater improvement in Group A, at the beginning of the year.

In School 2, in which participants already had considerable skill, Group B improved more for three out of the five aspects

Table 6.9 Confidence Intervals (CI) for the Timing in the Year

Ass 1/2 Group A	**Timing in the year**					
	School 1A		**School 2A**		**School 3A**	
	CI	p-value	CI	p-value	CI	p-value
Grip	-11.75 to -0.25	0.05	-22.17 to -7.83	0.05	-16.83 to -5.17	0.05
Motion	-36.36 to -17.64	0.05	-28.50to -11.50	0.05	-22.96 to -7.04	0.05
Approach	-19.18 to -4.82	0.05	-13.07 to 3.07	ns	-25.47 to -10.53	0.05
Accuracy	-25.59 to 5.59	ns	-19.46 to 3.46	ns	-66.20 to -43.80	0.05
Time	-7.-7 to 1.07	ns	-0.19 to 4.19	ns	-8.85 to 2.85	ns
Ass 2/3 Group B	**Timing in the year**					
	School 1B		**School 2B**		**School 3B**	
	CI	p-value	CI	p-value	CI	p-value
Grip	-6.48 to 2.48	ns	-7.79 to 1.79	ns	-15.05 to 1.05	ns
Motion	-24.87 to -5.13	0.05	-17.93 to -0.07	0.05	-37.77 to -16.23	0.05
Approach	-14.32 to -1.68	0.05	-18.03 to -1.97	0.05	-26.69 to -5.31	0.05
Accuracy	-28.57 to -1.43	0.05	-23.10 to -0.90	0.05	-57.39 to -24.61	0.05
Time	-4.85 to 0.85	ns	-1.10 to 3.10	ns	-5.95 to 7.95	ns

Significance $p \leq 0.05$

ns = not significant

Table 6.9 illustrates that both Group A and Group B improved statistically the same number of times. The areas of improvement vary. For Group A, statistical improvement can be seen for scissor grip, cutting motion, cutting approach and also cutting accuracy. In Group B, statistical improvement can be seen for cutting motion, cutting approach and also cutting accuracy in all three schools.

Thus there is little difference when groups are considered in terms of confidence intervals and the percentage improvement must be taken into account for the effectiveness of the SASSP to be considered in terms of when it is presented. It is apparent that previous skill and the different aspects of cutting may play a role in this aspect.

6.2.5 Equivalence

6.2.5.1 Medians of percentiles to establish the comparative position after intervention

By analysing the medians of percentiles in accuracy of cutting out a circle and a square in the period after the intervention, the relative position of each group to each other could be evaluated.

Table 6.10 Medians of percentiles of Group A and B for all Schools Pre and Post Intervention

Ass 1/2 Group A	School 1		School 2		School 3	
Ass 2/3 Group B	Group A	Group B	Group A	Group B	Group A	Group B
Square Pre-intervention	86	90	87	100	9	29
Square Post-intervention	100	96	96	100	94	78
Circle Pre-intervention	62	67	81	91	9	14
Circle Post-intervention	91	80	88	100	84	72

Table 6.10 illustrates the medians of percentiles scored for the accuracy of cutting out the square and circle before intervention and also after intervention. School 2B scored the highest percentile before and also after intervention. School 2B also shows, that they have achieved the same skill level for both the square and the circle, although the circle is the more complex shape to cut out. School 3A and School 3B show the initial low scores and also the improvement through intervention. When looking at the medians of percentiles post-intervention, School 3A scores on a similar level to the other schools for cutting accuracy of the square. Here, School 3B lags considerably behind with the score falling on the 78th percentile. When looking at the accuracy of the circle, School 3A scored higher than School 1B. School 3B again lagged behind the other schools.

6.2.5.2 Percentage change in Scissor Skills after Intervention to establish equivalence

Here, the scores for the scissor skills before and after intervention for the three schools are compared to each other. Scores are compared in order to establish if the school with the lowest scores was able to close the gap and attain similar scores to the other schools at the end of intervention. An initial assessment was done, in order to establish a baseline against which one could measure the rate of improvement and also against which one could compare initial gaps present between the schools. The following table summarises the mean percentages for cutting skills at baseline.

Table 6.11 Mean Percentages for Cutting Skills at Assessment 1

	School 1		**School 2**		**School 3**	
	Group A	Group B	Group A	Group B	Group A	Group B
Scissor Grip	83	84	79	87	73	76
Cutting Motion	51	57	58	70	41	46
Cutting Approach	58	53	63	65	36	33
Cutting Accuracy	71	66	79	83	21	22
Cutting Time	81	79	85	82	72	78

Table 6.11 illustrates the differences between Group A and Group B at all three schools at assessment 1. School 3 had the weakest score (in mean percentage) in all of the categories. In overall scissor skills, groups A and B were considered to be equivalent. (Appendix HH)

Table 6.12 Confidence Intervals (CI) at Assessment 1

Ass 1	1A vs2A		1A vs 2B		1B vs 2A	
	CI	p-value	CI	p-value	CI	p-value
Grip	-3.43 to 11.43	ns	-9.82 to 1.82	ns	-11.70 to 1.70	ns
Motion	-16.56 to 2.56	ns	-28.46 to -9.54	0.05	-9.58 to 11.58	ns
Approach	-12.08 to 2.08	ns	-14.97 to 0.97	ns	2.41 to 17.59	0.05
Accuracy	-21.91 to 5.91	ns	-25.44 to 1.44	ns	-0.65 to 26.65	ns
Time	-7.13 to -0.87	0.05	-4.65 to 2.65	ns	0.57 to 11.43	0.05
	1B vs 2B		2A vs 3A		2A vs 3B	
	CI	p-value	CI	p-value	CI	p-value
Grip	-8.06 to 2.06	ns	-0.63 to 12.63	ns	-5.22 to 11.22	ns
Motion	-23.44 to -2.56	0.05	8.76 to 25.24	0.05	-0.05 to 24.05	ns
Approach	-20.32 to -3.68	0.05	19.28 to 34.72	0.05	19.42 to 40.58	0.05
Accuracy	-30.20 to -3.80	0.05	46.22 to 69.78	0.05	41.13 to 72.87	0.05
Time	-8.64 to 2.64	ns	7.28 to 18.72	0.05	2.37 to 11.63	0.05
Ass 1	1A vs 3A		1A vs3B		1B vs 3A	
	CI	p-value	CI	p-value	CI	p-value
Grip	3.65 to 16.35	0.05	-0.78 to 14.78	ns	-16.80 to -5.20	0.05
Motion	1.83 to 18.17	0.05	-7.02 to 17.02	ns	-24.78 to – 7.22	0.05
Approach	13.98 to 30.02	0.05	14.01 to 35.99	0.05	-25.08 to -8.92	0.05
Accuracy	37.08 to 62.92	0.05	31.61 to 66.39	0.05	-57.56to -32.44	0.05
Time	2.98 to 15.02	0.05	-2.11 to 8.11	ns	-13.68 to -0.32	0.05
	1B vs 3B		2B vs 3A		2B vs 3B	
	CI	p-value	CI	p-value	CI	p-value
Grip	0.96 to 15.04	0.05	-19.65 to -8.35	0.05	4.18 to 17.82	0.05
Motion	-1.66 to 23.66	ns	-37.13 to -20.87	0.05	12.13 to 35.87	0.05
Approach	8.97 to 31.03	0.05	-37.08 to -20.92	0.05	20.97 to 43.03	0.05
Accuracy	27.11 to 60.89	0.05	-73.42 to -50.58	0.05	45.62 to 76.38	0.05
Time	-5.66 to 7.66	ns	-15.78 to -4.22	0.05	-0.93 to 8.93	ns

Significance p≤0.05

ns = not significant

Table 6.12 shows the confidence intervals at assessment 1 between all the groups and all the schools for five aspects of scissor skills. Statistically significant differences were found especially between School 3 and the other two schools. This was true for all aspects of scissor skills between School 3A and both the groups of School 2 and School 1 (except for scissor grip when compared to School 2A). School 3B scored significantly lower particularly when compared to School 2B and in approach and accuracy when compared to School 1. School 2B had the highest initial scores and was significantly better than School 1B in all aspects except grip and time.

Thus Figure 6.6 represents the amount of improvement in School 3A and School 3B relative to the other two schools. The graph indicates the difference still present between School 3 and the other two schools after intervention. The difference between the School 3 scores and the other two schools decreased (between 4% and 47%) when comparing the pre-intervention and post-intervention scores on the various aspects of scissor skills. (Appendix II). When the gap between the schools was less than 10% mean percentage, the level of performance of all participants was considered acceptable. This was based on the premise in schools in South Africa, which use a 10% difference as significant, as the symbol obtained for class performance changes with every 10% added. (103,104,106)

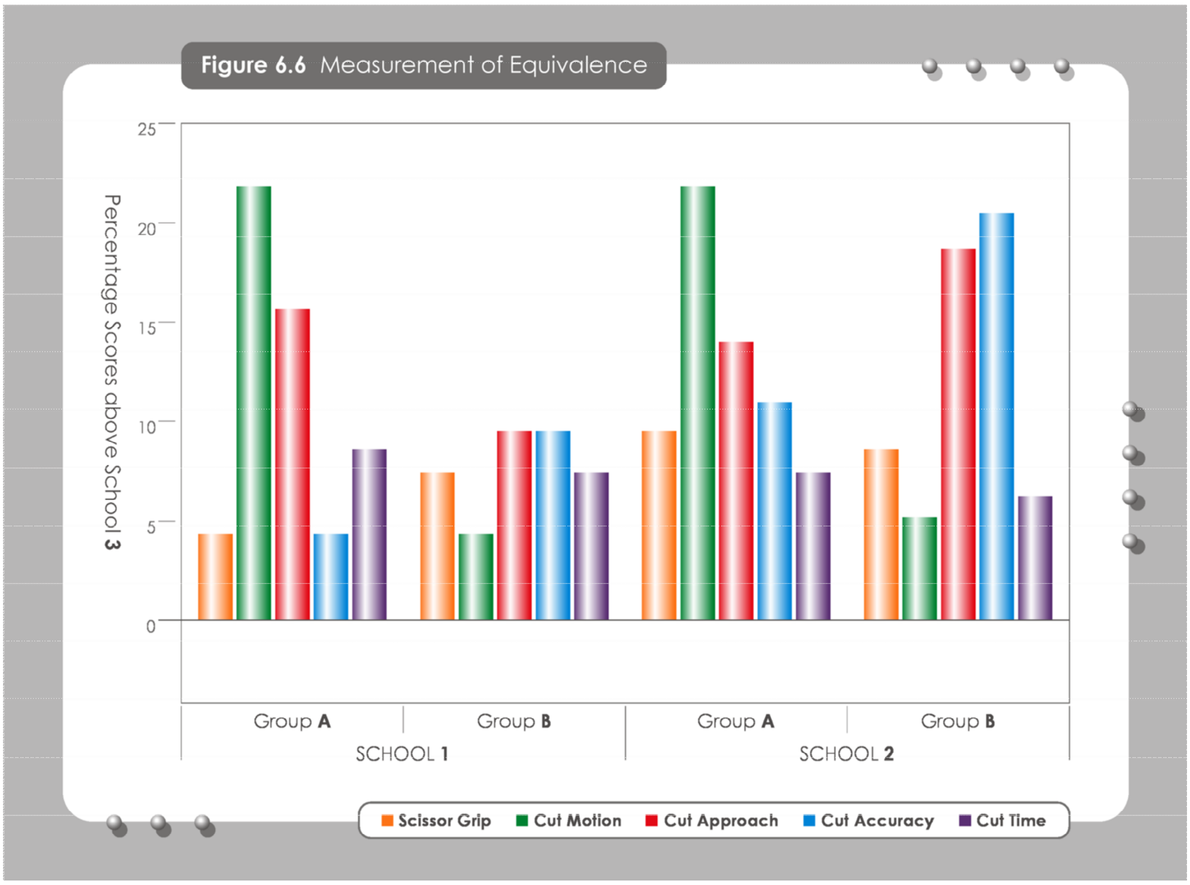


Figure 6.6 Measurement of Equivalence

As can be seen in figure 6.6 for cutting motion and approach, the scores for Group A in both School 2 and School 1 remain significantly higher than the scores for School 3 (Table 6.13). The scores for participants in School 1 and 2 actually increased more than those in School 3 (by 12% and 5% respectively) as a result of intervention. School 2A also increased their skill in scissor grip when compared to School 3A by 4% as they showed greater improvement with intervention (Table 6.13). School 3A closed the significant gap that previously existed with School 1, for scissor grip and cutting accuracy.

Only cutting accuracy improved enough not to be significantly different in School 3 after intervention.

Table 6.13 Confidence Intervals (CI) for Group A at different Schools at Assessment 2

Assessment 2	1A vs 2A		1A vs 3A		2A vs 3A	
	CI	p-value	CI	p-value	CI	p-value
Grip	-10.38 to 0.38	ns	-1.18 to 11.18	ns	3.37 to 16.63	0.05
Motion	-8.20 to 8.20	ns	12.25 to 31.75	0.05	12.87 to 31.13	0.05
Approach	-6.20 to 10.20	ns	8.06 to 23.94	0.05	5.35 to 22.65	0.05
Accuracy	-19.33 to 7.33	ns	-8.83 to 18.83	ns	-1.38 to 23.38	ns
Time	-2.36 to 4.36	ns	3.23 to 14.77	0.05	2.63 to 13.37	0.05

Significance p≤0.05

ns = not significant

The analysis of cutting time was considered separately again. Here a difference of 10% is still a large gap in terms of speed of work. There was a statistically significant difference between both Group A and B at School 3 and the other two schools after intervention (Table 6.13 and 6.13). (Appendix II)

School 3B still lagged significantly behind School 2B in cutting approach and cutting accuracy (Table 6.14). However, School 3B closed the gap in terms of mean percentages towards School 1B as all scores were less than 10% difference (Figure 6.6). However, statistically, there was significant difference for scissor grip and cutting approach (Table 6.14).

Cutting motion was the one aspect of scissors skills that achieved equivalence in all Group B's of all three schools (Table 6.14).

It is interesting to note that the greatest difference in Group A was cutting motion whereas for group B this became approach and accuracy (Figure 6.6).

Table 6.14 Confidence Intervals (CI) for Group B at different Schools at Assessment 3

Assessment 3	1B vs 2B		1B vs 3B		2B vs 3B	
	CI	p-value	CI	p-value	CI	p-value
Grip	-5.05 to 3.05	ns	2.29 to 13.71	0.05	3.35 to 14.65	0.05
Motion	-9.64 to 7.64	ns	-5.08 to 15.08	ns	-3.66 to 15.66	ns
Approach	-16.23 to -1.77	0.05	2.14 to 17.86	0.05	10.57 to 27.43	0.05
Accuracy	-20.25 to -1.75	0.05	-2.02 to 22.02	ns	10.65 to 31.35	0.05
Time	-1.77 to 3.77	ns	2.09 to 13.91	0.05	1.62 to 12.38	0.05

Significance p≤0.05

ns = not significant

Table 6.14 shows the various statistically significant differences still present after intervention. These are not only towards School 3B, but also towards School 1B.

The following figure shows the increase in mean percentages in each group, indicating the rate of improvement as a result of the scissor skills program.

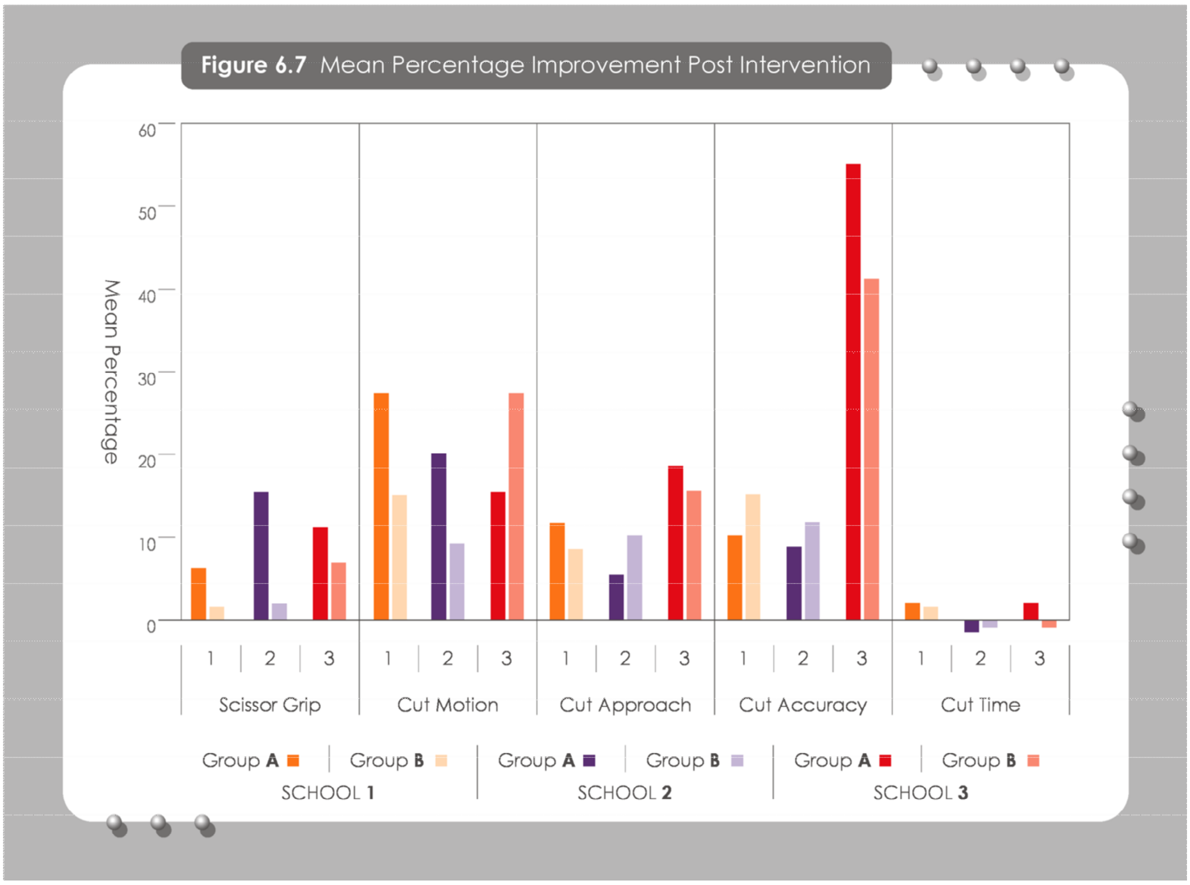


Figure 6.7 Change in Scissor Skills Post Intervention

Figure 6.7 shows the improvement in each group, given in mean percentage scores. As can be seen School 3 showed the greatest improvement in both groups for cutting approach and also cutting accuracy.

6.3 Bilateral Fine Motor Assessment Based Results

6.3.1 Results of Three Bilateral Fine Motor Assessments

The entire fine motor bilateral assessment was completed each time on all of the participants. The changes after intervention as well as the period with no intervention are considered.

Table 6.15 Mean Percentages for Bilateral Skills at Assessment 1

	School 1		**School 2**		**School 3**	
	Group A	Group B	Group A	Group B	Group A	Group B
Name writing	59	65	55	54	57	57
Drawing around	40	60	45	52	30	30
Tearing	23	21	35	45	17	22
Threading	54	53	54	50	48	47
Tying Shoelaces	22	24	48	50	57	43
Closing Buttons	84	82	87	89	83	85

Table 6.15 illustrates the mean percentages scored for each group in each school at assessment 1. For the bilateral items, School 3 did not always score the weakest mean percentage score. In 50% of the items, either Group A or Group B of School 3 scored the weakest score. In 33% of the items, School 1 scored the weakest score and in one task (name writing), School 2 scored the weakest score. School 2 was tested slightly later (May) in the year for this initial assessment, whereas School 1 and School 3 were assessed in March, thus not having had as much input from their respective teachers. Closing buttons and threading are two categories, where all groups scored within 7% of each other, indicating that those skills seemed to be fairly equally developed. In the other categories, skill levels were found to be further apart,

with name writing (11% range), tearing (28% range), drawing around an object (30% range) and tying shoelaces (35% range).

When looking at the confidence interval, there was only one statistically significant difference between Group A and Group B at assessment 1 for drawing around an object at School 1. All other scores were not statistically significant. (Appendix HH)

Table 6.16 Confidence Intervals (CI) at Assessment 1 (Bilateral Items)

Ass 1	1A vs 2A		1A vs 2B		1B vs 2A	
	CI	p-value	CI	p-value	CI	p-value
Name	-6.84 to 14.84	ns	-5.40 to 15.40	ns	-21.43 to 1.43	ns
Object	-17.64 to 7.64	ns	-23.63 to -0.37	0.05	-26.74 to -3.26	0.05
Tearing	-27.66 to 3.66	ns	-34.79 to -9.21	0.05	-0.68 to 28.68	ns
Beads	-9.35 to 9.35	ns	-4.24 to 12.24	ns	-7.57 to 9.57	ns
Shoelaces	-46.02 to -5.98	0.05	-48.42 to -7.58	0.05	5.36 to 42.64	0.05
Buttons	-7.09 to 1.09	ns	-8.80 to -1.20	0.05	0.21 to 9.79	0.05
	1B vs 2B		2A vs 3A		2A vs 3B	
	CI	p-value	CI	p-value	CI	p-value
Name	0.00 to 22.00	0.05	-10.28 to 6.28	ns	-12.69 to 8.69	ns
Object	-2.76 to 18.76	ns	5.80 to 24.20	0.05	3.74 to 26.26	0.05
Tearing	-35.9 to -12.10	0.05	5.88 to 30.12	0.05	-3.20 to 29.20	ns
Beads	-4.48 to 10.48	ns	-1.23 to 13.23	ns	-1.08 to 15.08	ns
Shoelaces	-45.05 to -6.95	0.05	-26.16 to 8.16	ns	-13.87 to 23.87	ns
Buttons	-11.53 to -2.47	0.05	-1.39 to 9.39	ns	-3.20 to 7.20	ns
	1A vs 3A		1A vs3B		1B vs 3A	
	CI	p-value	CI	p-value	CI	p-value
Name	-5.69 to 9.69	ns	-7.86 to 11.86	ns	-16.20 to 0.20	ns
Object	0.02 to 19.98	0.05	-2.35 to 22.35	ns	-39.30 to -20.70	0.05
Tearing	-4.40 to 16.40	ns	-12.92to 14.92	ns	-13.72 to 5.72	ns
Beads	-0.39 to 12.39	ns	0.39 to 13.61	0.05	-10.81 to 0.81	ns
Shoelaces	-52.62to-17.38	0.05	-40.41 to -1.59	0.05	16.47 to 49.53	0.05
Buttons	-4.86 to 6.86	ns	-6.95 to 4.95	ns	-4.97 to 6.97	ns

Significance $p \leq 0.05$

ns = not significant

Table 6.16 (continued) Confidence Intervals (CI) at Assessment 1 (Bilateral Items)

Ass 1	1B vs 3B		2B vs 3A		2B vs 3B	
	CI	p-value	CI	p-value	CI	p-value
Name	-2.58 to 18.58	ns	-4.96 to 10.96	ns	-13.26 to 7.26	ns
Object	18.54 to 41.46	0.05	-30.46to-13.54	0.05	11.77 to 32.23	0.05
Tearing	-13.98to 11.98	ns	-38.14to-17.86	0.05	9.46 to 36.54	0.05
Beads	0.20 to 11.80	0.05	-8.45 to 4.45	ns	-3.90 to 9.90	ns
Shoelaces	-37.04 to -0.96	0.05	-10.32to 24.32	ns	-12.31 to 26.31	ns
Buttons	-9.31 to 3.31	ns	-11.19 to -0.81	0.05	-0.93 to 8.93	ns
	1A vs 1B		2A vs 2B		3A vs 3B	
	CI	p-value	CI	p-value	CI	p-value
Name	-4.00 to 16.74	ns	-12.12to 10.12	ns	-7.59 to 7.59	ns
Object	7.22 to 32.76	0.05	-3.54 to 17.54	ns	-8.98 to 8.98	ns
Tearing	-14.17to 10.17	ns	-5.17 to 25.17	ns	-5.93 to 15.93	ns
Beads	-8.31 to 6.31	ns	-13.34 to 5.34	ns	-6.37 to 4.37	ns
Shoelaces	-17.17to 21.17	ns	-17.87to 21.87	ns	-30.78 to 2.78	ns
Buttons	-7.54 to 3.54	ns	-0.72 to 4.72	ns	-4.25 to 8.25	ns

Significance p≤0.05

ns = not significant

Table 6.16 shows the confidence intervals between all groups and schools at assessment 1. Statistically significant differences were found scattered between the schools. For name writing and threading beads, most differences were not statistically significant. For tearing, there was mainly statistical difference toward School 2B, as that group scored the highest score out of all groups. This was similar for closing buttons, where School 2 scored the highest. There was great fluctuation in the scores obtained for drawing around an object and this was represented in the statistically significant differences between the various groups and schools, with only three groups showing no statistically significant difference. For tying shoelaces, School 1 scored the lowest and showed statistically significant difference towards all other groups and schools.

6.3.2 Changes in Bilateral fine motor skills after intervention with the SASSP – Transferability of Skills

Change in all fine motor bilateral tasks was analysed after the scissor skills program. Thus the first and second assessment for Group A and the second and third assessment for Group B were compared. (Appendix JJ)

This was to establish if changes found in the scissor skills program related to changes in other bilateral fine motor skills.

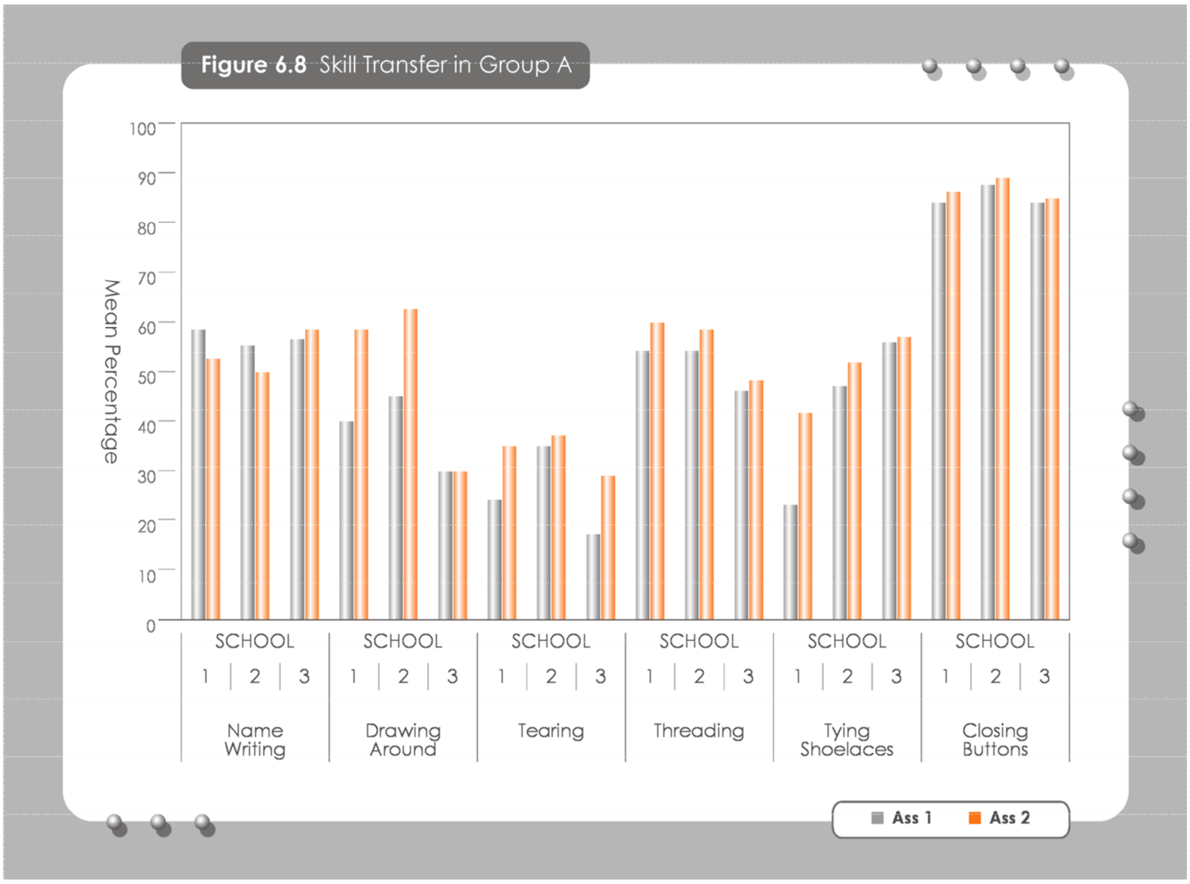


Figure 6.8 Skill Transfer in Group A

Figure 6.8 illustrates the changes observed in bilateral items, when comparing the assessment before and after the intervention. For name writing, there is a slight decrease (6% and 4% respectively) in skill in School 1 and School 2, however, none are statistically significant (Table 6.17). For all of the other categories there is no change, or an increase in skill level (ranging from 0% to 19%). Marked improvement can be seen for ‘Drawing around an object’, yet only for School 1 ($p \leq 0.05$) and

School 2 (p ≤ 0.05). In tearing, there is marked improvement for School 1 (12%) and School 3 (p ≤ 0.05). For tying shoelaces there is marked improvement of skill in School 1 (19% - not statistically significant). Tearing shows statistically significant improvement (p ≤ 0.05) for School 3. No statistically significant change was seen in threading, tying shoelaces and closing buttons. (Table 6.17)

Table 6.17 Confidence Intervals (CI) for Skill Transfer in Group A

Ass 1/2 Group A	**Skill Transfer**					
	School 1A		School 2A		School 3A	
	CI	p-value	CI	p-value	CI	p-value
Name	-3.67 to 15.67	ns	-7.71 to 15.71	ns	-9.29 to 5.29	ns
Draw around	-33.36 to -4.64	0.05	-28.84 to -7.16	0.05	-6.84 to 6.84	ns
Tearing	-25.41 to 1.41	ns	-16.66 to 14.66	ns	-20.87 to -3.13	0.05
Threading	-13.80 to 1.80	ns	-14.35 to 4.35	ns	-6.37 to 4.37	ns
Shoelaces	-39.90 to 1.90	ns	-23.72 to 15.72	ns	-15.08 to 13.08	ns
Buttons	06.41 to 2.41	ns	-4.40 to 2.40	ns	-6.39 to 4.39	ns

Significance p≤0.05

ns = not significant

Table 6.17 shows that there was little statistically significant improvement after the intervention program in most of the bilateral items.

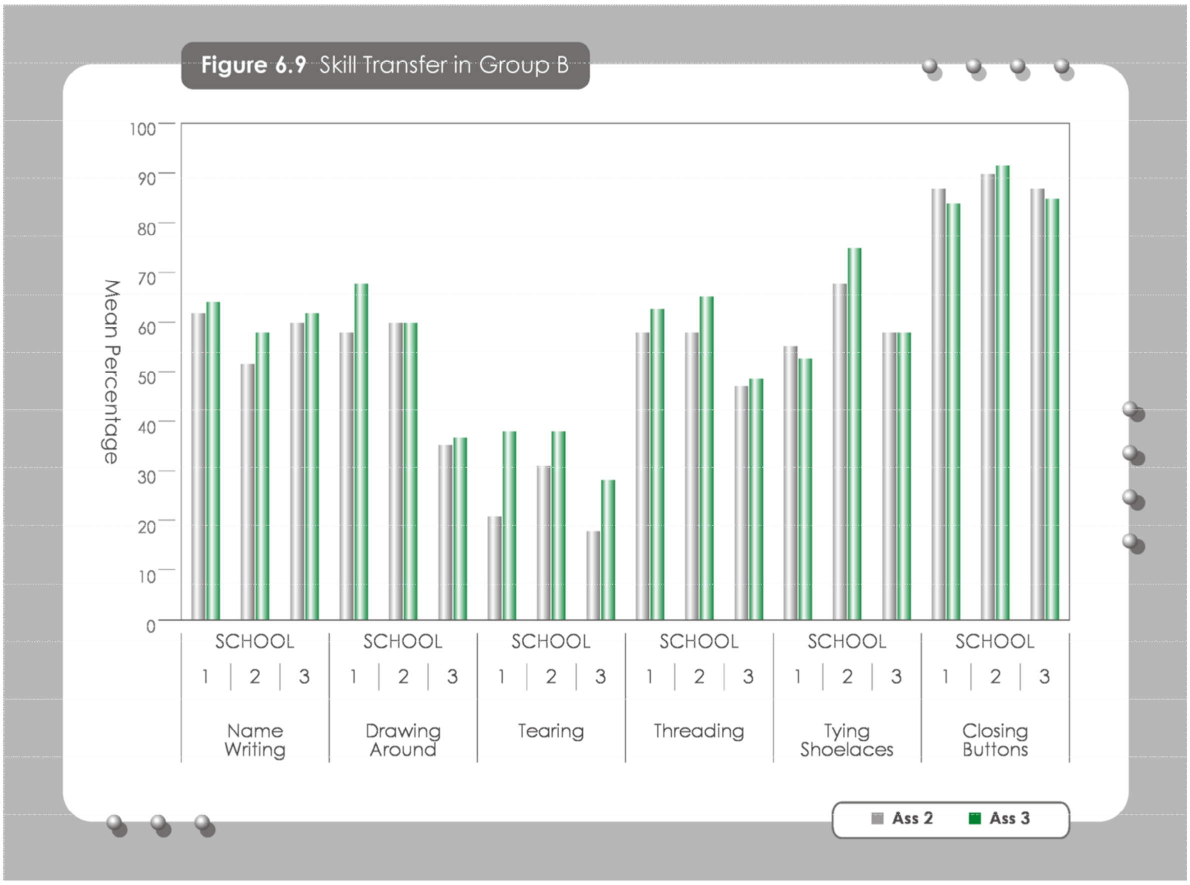


Figure 6.9 Skill Transfer in Group B

Figure 6.9 illustrates the changes observed in bilateral items for Group B, when comparing mean percentages before and after intervention. There is a slight decrease in skill on three occasions, namely for tying shoelaces in School 1 (-1%) and for closing buttons in School 1 (-2%) and School 3 (-1%). For all of the other categories there is no change, or an increase in skill level (ranging from 0% to 17%). The category of tearing improved the most, especially in School 1 ($p \leq 0.05$ in Table 6.18) and School 3 (11%). Threading in School 2 showed statistically significant changes ($p \leq 0.05$). No other changes over the two assessments were of statistical significance (Table 6.18).

Table 6.185 Confidence Intervals (CI) for Skill Transfer in Group B

	Skill Transfer					
Ass 2/3 Group B	School 1B		School 2B		School 3B	
	CI	p-value	CI	p-value	CI	p-value
Name	-12.88 to 6.88	ns	-15.02 to 5.02	ns	-12.70 to 10.7	ns
Draw around	-22.21 to 2.21	ns	-10.40 to 10.40	ns	-11.12 to 9.12	ns
Tearing	-30.64 to -3.36	0.05	-19.53 to 7.53	ns	-24.29 to 2.29	ns
Threading	-13.22 to 3.22	ns	-15.75 to -0.25	0.05	-8.68 to 6.68	ns
Shoelaces	-17.33 to 19.33	ns	-21.59 to 7.59	ns	-20.21 to 20.21	ns
Buttons	-7.79 to 11.79	ns	-3.10 to 1.10	ns	-4.06 to 6.06	ns

Significance p≤0.05

ns = not significant

Table 6.18 shows only two statistically significant changes in Group B after intervention, in other bilateral items.

For transfer of changes in scissor skills to have been reflected in changes in other bilateral fine motor skills there needed to be an improvement in both Group A and Group B and in all three schools. Improvement in mean percentages was observed in all groups in all schools for tearing and threading only, however they were not consistently high, with some groups only improving by 1%. The analysis of confidence intervals supports the findings that there is no skill transfer from cutting to any of the bilateral items.

6.3.3 Changes in Bilateral fine motor skills ('maturation')

All bilateral items were evaluated over the year. (Cutting skills were considered separately).

Being in a class, however, children are participating in daily activities and in a curriculum. Thus they are receiving input and are able to learn; skills are thus not 'maturing', where it is expected that the skill develops due to age. (9. 10) The rate of change occurring with the normal school program was thus considered, where children are learning in their class environments and are benefiting from input.

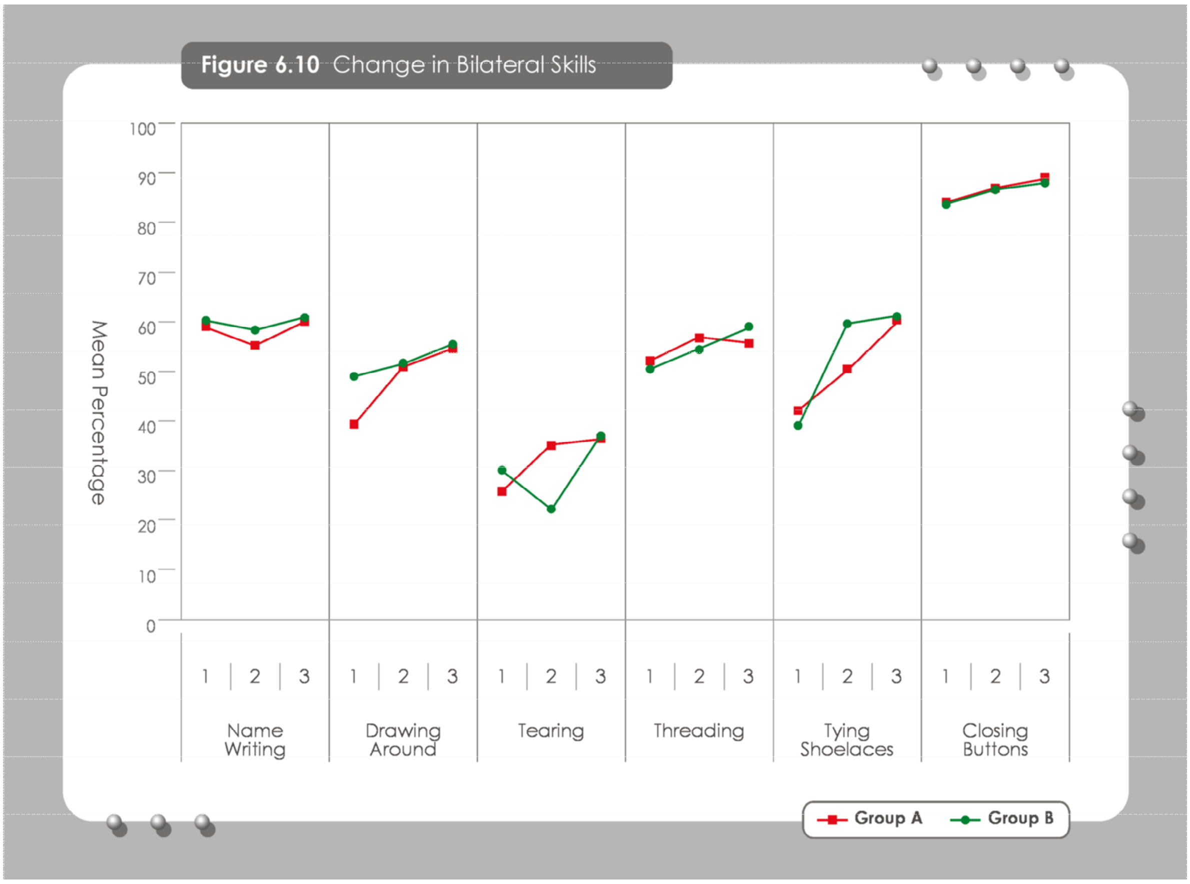


Figure 6.10 Change in Bilateral Skills given in Mean Percentage Scores

Figure 6.10 shows the change of bilateral items over the three assessments in both Group A and Group B. The red line represents Group A of all three schools, calculated in mean percentage. The green line represents Group B of all three schools, calculated as mean percentage score. Overall improvement in both groups over all three assessments can be seen for drawing around an object, tying shoelaces and closing buttons only. The other bilateral items showed a decrease in performance in at least one of the groups between the three assessments.

There was a general trend of improvement from one assessment to the next. Overall this was marginal ranging between 0 and 5%. On some occasions, there was a marked improvement ranging between 12 and 21%, and on some occasions, there was a decrease in performance ranging between -1 and -3%.

The biggest improvement in mean percentage, across all schools and all groups could be seen for the category of tying shoelaces.

Tearing as a category also showed much improvement (Appendix KK), especially for School 1 and 3. Here school 2 already scored better than the other 2 schools on the first assessment.

Buttoning did not show much improvement (between 0 and 3%), however, all three schools already scored high mean percentage scores, showing that they were already able to do this skill fairly well. (Appendix KK)

ANOVA analysis also found that there were significant changes within the categories of tearing (p= 0.004), tying shoelaces (p= 0.006) and buttoning (0.027) Table 6.18.

Table 6.19 ANOVA p Values for Normal Bilateral Development

	Normal Bilateral development					
	Name	Draw around object	Tearing	Threading	Shoelaces	Buttons
ANOVA p Value	0.854	0.075	0.004	0.240	0.006	0.027

Significance $p \leq 0.05$

ns = not significant

As mentioned, skills generally improved; these were important to the participants and they showed real effects. Statistical improvement as seen with confidence intervals was scattered throughout the categories, between assessments and also groups (Appendix HH). This indicates that those groups showed improvement due to teacher input at that time and that those classes seemed to have been targeting that particular skill.

6.4 Program Evaluation

The program is evaluated in terms of the practice component, the picture component, a comparison between the two as well as teacher's perceptions of the program. Further, the parent questionnaire is evaluated.

6.4.1 Practice Evaluation

The teachers were asked to collect specific practice items, which were collected and evaluated. (Chapter 5) The results are more accurate for School 1 and School 2, as the data was more complete.

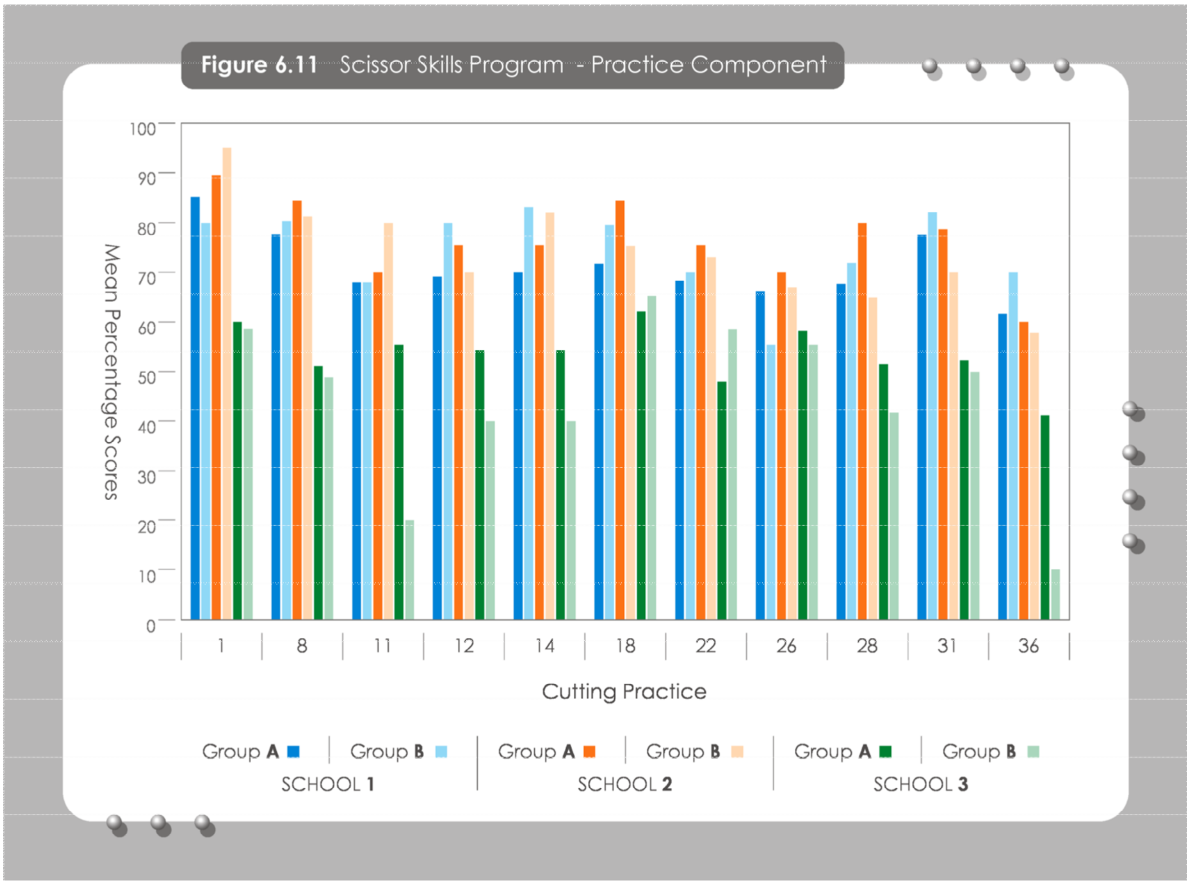


Figure 6.11 Practice Component of the SASSP

Practice 1 Straight Line
Practice 8 Wide Zig-Zag
Practice 11 Square Spiral
Practice 12 Narrow Zig-Zag
Practice 14 Frog Jumps
Practice 18 Wave
Practice 22 Straight Line with Bumps

Practice 26 Narrow Waves

Practice 28 Upper and Lower Circles

Practice 31 Spiral

Practice 36 Circle

Figure 6.11 summarises the mean percentage scored for the practice components of the scissor skills program. The mean percentage scores indicate how accurately the children were able to cut out the practice component of the program. Most of the practice components were returned for School 1 and School 2, thus making those results more reliable. School 3 did not return all of the practice components and those that were returned were not always complete affecting the reliability of these results. Most participants scored high indicating that the practice sheets were within their skill level. The scores of School 1 and School 2 ranged between 56% and 95% with most of them above 70%. For five of the six groups, the circle had the lowest average score, showing the difficulty in cutting out the circular shape. Group B in School 1 had the lowest score for the narrow waves. (Appendix LL)

Generally School 3 had the lowest scores out of all groups, with Group B having six of the 11 scores below 50% and their highest score being only 65%.

Table 6.20 Medians of percentiles of all Groups for the Practice Component of the SASSP

Practice	**School**					
	1A	**1B**	**2A**	**2B**	**3A**	**3B**
Straight Line	93	87	99	100	73	76
Wide zigzag	83	89	93	90	70	54
Narrow zigzag	74	84	82	78	67	44
Square Spiral	69	81	72	92	66	9
Frog Jumps	78	87	79	90	58	49
Wave	84	92	93	90	74	81
Straight Line with Bumps	74	78	84	84	69	67
Narrow Waves	73	64	79	76	74	54
Upper and Lower Circles	77	82	89	68	68	52
Spiral	94	89	91	88	71	72
Circle	69	79	74	58	57	-

Table 6.20 indicates the percentile scores for all schools. There was no score for the circle for School 3B as there was only one result available. School 3A or school 3B consistently had the lowest percentile score. However, overall the scores were high. School 1 and 2 generally scored above the 75^{th} percentile, with School 1B only scoring one category (narrow waves) below. School 3 generally scored between the 50^{th} and the 75^{th} percentile. School 3B managed two categories above the 75^{th} percentile and three below. The lowest medians of percentiles fluctuated between the circle and the square spiral, with the exception of School 1B, who scored the lowest percentile for narrow waves. (Appendix MM)

6.4.2 Picture Evaluation

All children received books into which they were able to stick their pictures. These were collected and evaluated, and then returned to them. (Appendix NN) The following figure groups the pictures according to straight-line designs, gentle curves, prominent curves, designs with circular parts, many changes in direction and complex designs. (Appendix NN)

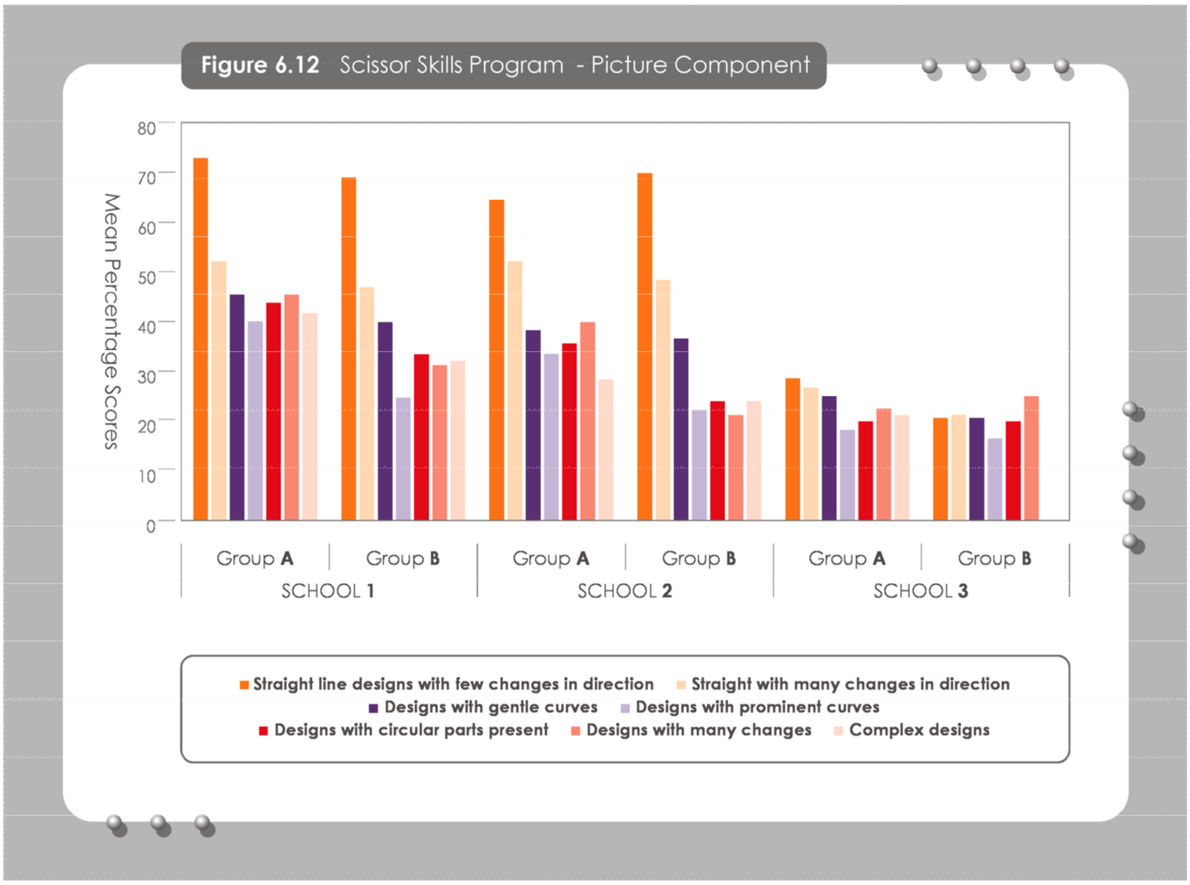


Figure 6.12 Picture Component of the SASSP

Figure 6.12 summarises the mean percentage scores of the picture component of the cutting program. The mean percentage scores per picture gave an indication of how accurately children were able to cut out the pictures. No score was present in School 3B for complex designs as these were not returned by the teacher. Four of the six groups showed the lowest mean percentage for designs with prominent curves. Most groups had the highest score for the two straight-line design groups. Most scores were below 40% mean percentage.

Table 6.21 Medians of percentiles of all Groups for the Picture Component of the SASSP

Picture	School					
	1A	1B	2A	2B	3A	3B
Flag	80	68	80	86	18	10
Book	67	84	84	84	13	8
House	78	83	77	78	23	11
Boat	77	59	76	57	18	8

Tree	60	52	54	63	24	7
Fence	61	55	64	53	31	23
Sun	47	33	44	36	20	21
Castle	41	44	63	44	22	19
Balloon	30	27	27	28	19	22
Owl	37	37	25	23	12	7
Kite	51	44	43	42	24	21
Car	17	16	17	29	7	7
Flower	28	9	34	12	7	6
Hippo	34	22	26	24	7	8
Tortoise	28	17	20	17	8	8
Tree	42	16	24	15	7	7
Elephant	31	19	18	26	9	17
Bird	49	22	24	25	18	14
Dog	42	28	29	26	23	19
Pear	34	12	36	13	11	7
Ladybird	29	26	26	24	10	16
Duck	59	53	49	51	24	49
Camel	36	42	34	19	9	7
Apple	29	24	16	9	7	7
Parrot	44	25	29	7	15	19
Cat	38	37	42	32	22	19
Mouse	42	31	43	22	9	19
Snail	39	14	25	14	8	8
Fish	47	36	39	29	22	-
Squirrel	31	29	43	24	34	-
Hen	29	23	15	19	13	-
Croc	49	34	23	24	21	-
Horse	39	33	12	24	0	-

Table 6.21 indicates the percentile scores for all schools. There was no score for the last five pictures for School 3B as the pictures were not returned by the teacher. School 3 had the lowest percentile score in 88% of the pictures. Overall the scores were low. Only the first four pictures achieved scores of above the 75th percentile for School 1 and 2. Generally, School 1 and 2 scored between the 50th and the 25th percentile, with 22% scoring above the 50th percentile and 27% below the 25th percentile. School 3 generally scored below the 25th percentile. (Appendix MM)

6.4.3 Picture versus Practice Evaluation

The practice component was done first every day, followed by the picture component of the scissor skills program. The following figure shows the difference between the practice and the picture component.

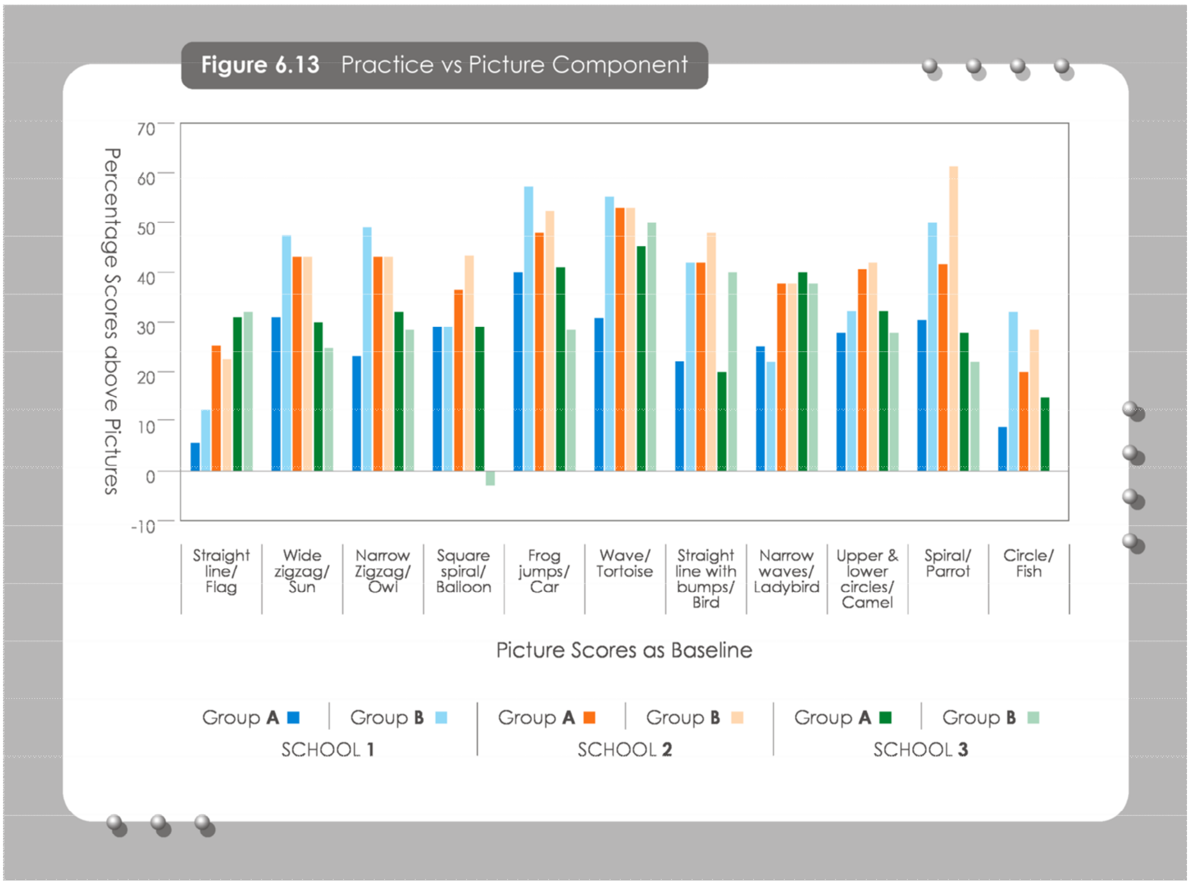


Figure 6.13 Practice versus Picture Component of the SASSP

Figure 6.13 illustrates the comparison of practice component with the relevant picture component. The picture score, which in most instances was the lower score, is used as the baseline. The coloured bars represent the difference between the picture score and the practice score, thus the higher the bar, the greater the difference between the two scores. In almost all of the cases, the practice component scored higher than the picture component. There was only one exception where Group B of School 3 scored 4% better when cutting out the picture (balloon), when this was compared to the corresponding practice component (square spiral).

On only three occasions are mean percentages of practice and picture components within 10% of each other. (Appendix OO)

6.5 Teachers perceptions of the program

Teachers were asked to complete a rating scale with questions about the scissor skills program. (Appendix PP)

Table 6.22 Summary of Teacher's Comments

	School 1	School 1	School 2	School 2	School 3	School 3
Teacher	A	B	A	B	A	B
Suitability of pictures	Pictures were suitable to the children and they enjoyed the program	Pictures were suitable and children looked forward to the program	Pictures were appropriate	Pictures were suitable and children enjoyed them	She thought the pictures were suitable	Pictures were appropriate
Improvement in cutting skills	Skills improved markedly	Super program	Unsure how much children had learnt	Children improved, especially their cutting motion	She thought that some pictures were too difficult for the children	Children benefited from the program
Program length			4-5 times per week was too much	The program should run twice per week	She did not feel she had enough time to run the program every day	4-5 times per week was too much
Preparation time	The program did not assist in cutting down on preparation time	It did not cut down on preparation for her	Did not save on preparation time	It saved on prep time as she did not have to plan for this part of the lesson	The program helped this teacher with preparation for her class activities	It saved her some preparation time

6.6 Summary

School 3 scored the lowest mean percentage and percentile scores at assessment 1. Through the intervention program they made the greatest gains overall, although they lost ground comparative to other schools. Thus they were not able to close the gap towards other schools.

Bilateral fine motor skills showed a trend of improvement over the three assessments. However, the scissor skills program did not contribute to this; improvement, as it was not consistent over the groups and schools, seemed to have been related to teacher input.

The hypothesis that stated that there will be a difference in scissor skills of Grade 0 children attending schools in different socio-economic areas after an intense classroom based scissor skills program is accepted.

The null hypothesis that stated that there will be no difference in bilateral fine motor skills of Grade 0 children attending schools in different socio-economic areas after an intense classroom based scissor skills program is accepted.

7. DISCUSSION – CHAPTER 7

The discussion will review the findings in relation to the demographics of the schools, the scissor skills program and its effect on individual cutting skills, including the change of scissor skills with intervention, skill retention, change without intervention and timing of the intervention within the year. Results are also reviewed in terms of the unique South African context. Fine motor bilateral skills will be considered in terms of transferability from the scissor skills intervention into bilateral items tested in the assessments. The normal development of bilateral fine motor skills will also be considered. Finally a program evaluation, including the practice component and the picture component, as well as teacher involvement is covered.

Although the sample of participants had more male than female participants no significant difference between the groups in terms of gender was found. Age of the participants was controlled for in the study and fell between 4years 4months and 6years 4months. The participants in School 3 were younger than School 1 and School 2 on average by 3 to 7 months in Group A and 7 to 12 months in Group B (Table 5.1). 18 children in School 3B were born in 2002 (actually 2 years too young for that class) and were not included in the study, however, were still present in this classroom. This also has some impact on the daily running of that classroom. This indicates a trend in the lower socioeconomic areas where there is no free nursery school education so children are placed in Grade 0 too young.

The independent variable between the groups of participants in the three schools selected for the study was socio-economic status. This is an important factor to consider when working in a South African population as children come from varying socio-economic statuses and are affected by these in terms of their education. Although the government has worked towards equity in distributing resources in education since 1994, inequalities still exist because of inability for parents to pay fees in the poorer areas. Socio-economic indicators are those that still best define the unchanging picture in South African schools when the school cohort is divided into poverty quintiles.

> "Socio-economic indicators rather than race provide a much better explanatory frame for social change in post-apartheid South Africa.- .. The poor continue to be disadvantaged from the point of view of having equal opportunity to a meaningful quality education." (slide9) (107)

This study investigated the difference in the ability of the participants from the different socioeconomic levels. The selection of schools did not provide a sample that mirrors the distribution of the demographics in the South African population as many more children from the lower socio-economic backgrounds, as seen in School 3, would need to be included. (108)

Stratified sampling ensured that participants from three different socio-economic levels could be compared.

Participants at School 1 in a middle socio-economic area had learners from a variety of socio-economic backgrounds as some of the learners were bussed in from lower socio-economic areas. This is a common practice in the urban areas of South Africa. School fees are a few hundred rand a month.

Participants from a higher socio-economic background in School 2 attended a private school where fees are a few thousand rand a month. School 3 is in a low socio-economic area in a township area previously reserved for Blacks. The school fees range from a few rand a month to free schooling.

There were vast differences in the structure of the schools. School 2 had big classrooms with heating facilities and also appropriate seating and tables. School 1 had adequate facilities with enough space available in classes for appropriate tables and chairs. These were not of the same standard as for School 2, however, they were acceptable, with smooth work surfaces and stable frames. School 3 did not have much space; the classes were smaller than in School 2, although there were more learners present. Tables were of poor quality including uneven work surfaces and the chairs often had broken back rests. Learners had to share tables, thus limiting the space available. Thus basic work requirements were not met at School 3.

The main differences between the schools were the resources available to them in terms of physical and human resources. This reflects the inequalities that still exist in South African schools because of discrepant educator qualifications and unfavourable learner educator ratios and the vast disparities in resources and infrastructure that still exist between schools. (107)

It is the aim of the Education Department as stated in the Education White Paper 5 on ECD *(Early Childhood Development),* that all children have participated in an accredited Grade 0 program by 2010 (109) to prepare children for Grade 1. When children enter with different skills, the challenge is for all learners to be school-ready at the end of the year. However, in order for children to become school ready, the schools need to be able to provide them with input to facilitate learning and to achieve this goal.

A confounding variable in this study was the variability of the teachers, which is present in all school systems and is difficult to control. This included teacher education and experience, as well as personal attributes such as motivation and health. In this study, teachers had various educational levels as well as years of experience, affecting their knowledge on child development, requirements for Grade 0 and the ability to teach children. One of the teachers at School 3 was ill and absent herself during part of the program, thus being unable to present the program and complete it within time limits. After completion of the study, this teacher passed away due to ill health. This probably also affected her motivation, as she was not feeling well.

Learning takes place through practice, thus if the teacher is unable to impart skills to her learners, they miss out on that learning experience. Although children at School 3 showed improvement, it is felt that this could have been at a very different level, had the program been completed by the teacher in the allocated time with the correct guidance to the learners and had learner absenteeism not been such a problem.

Teacher motivation also affected the outcome of the study. The teachers at School 2, for instance had very different attitudes towards the program. One of them was able to understand and identify aims of the scissor skills program and was able to recognise traits for instance of cutting motion in her learners, thus indicating that she had the observational skill and knowledge to do so. She was thus able to integrate these observations when showing the learners how to carry out the movement efficiently. This teacher had a very positive attitude towards the program and she was able to identify which aspects of the scissor skills had improved within her classroom. Results show that her class scored among the highest, with statistically significant differences in most constructs towards the other groups.

Recommendations therefore are that Grade 0 teachers should be knowledgeable about developmental stages, addressing all aspects of school readiness. The teacher/pupil ratio should also not be too high, so that children can still benefit from teacher attention and teachers should also be trained to provide them with a variety of stimulating activities. Staff training is vital, to keep teachers up-to-date with information and the physical environment of the classroom is also important. (7, 26)

Teaching becomes more effective with the correct materials available. School 3 had fewer resources available to the teacher, thus limiting her ability to impart information to the learners. It has been found that resources in schools play a role in day-to-day participation within classrooms and development is put at risk, if the correct stimulation is lacking. (7) In a study by Engle et al, the absence of effect of schooling programs for early intervention were partly explained by poor quality of schools. (26)

Although in terms of the scissor skills program, everything was made available to School 3, placing them on par in terms of resources for the development of scissor skills, the classroom was more crowded, making the working conditions for the learners less than ideal. School 3 was the school with higher learner teacher ratios. (Table 5.3)

In winter, class rooms were very cold, resulting in school absences. This again affected the learner's ability to progress, as they were missing out on teaching time and practice of their skills. (93)

Children benefited from resources at school, as well as in the home environment. Table 6.2 shows, that participants from School 2 had the most resources available to them. They enjoyed early input in the form of high quality nursery schools, stable home environments as well as readily available resources. Children from School 3 were at a disadvantage in all of those aspects.

Group A and Group B at each school were in two separate classes. The level of functioning for both classes at any given school was fairly similar. (Appendix HH) A statistically significant difference, however, was found after Group A had participated in the intervention. This evened out at assessment 3, after which both groups had benefited from intervention. (Appendix HH)

The results, however, indicate that the participants entered Grade 0 with significantly different abilities in terms of scissor skills and other fine motor skills. This was related to the school they attended (Table 6.12 and 6.16), with the participants at School 3 from the lower socio economic area being the most disadvantaged. Longitudinal studies have shown that the socio-economic status at birth is associated with school attainment. (93)

The focus of this part of the study was to address the differences in ability found in this sample of learners from the various schools, in an attempt to ensure they were all prepared for Grade 1 in terms of scissor skills.

7.1 Effectiveness of the scissor skills program

An assessment of bilateral fine motor skills including various aspects of scissor skills was developed. Initially on baseline assessment 1, School 3 (Table 6.12) and School

1B had significantly lower scores than the participants in School 2, indicating a range of skill relating to the socio-economic status of this mixed population. (Table 6.12)
A program of specific scissor skills was introduced at various times in the year, over a ten week period. This intensity was important as a number of repetitions of the movement were required in order for it to become a skilled movement. (9)
Literature intimates that motor learning through practice, becomes a skilled task.

> "When the term 'skill' is used, the implication is that learning has taken place." (9 pg 103)

Quantification of learning a skill is complex and to quantify learning, this study compared initial performance with later performance and the establishment of the difference. According to McCraw (38), various 'learning' scores can be obtained, depending on how one looks at improvement. Each skill can also be represented by different learning curves. Ehrlich (39) recommends that curves should be constructed by including initial states, rate of learning and maximal end points. When assessing cutting accuracy, for instance, the maximum score was set at 100%. Medians of percentiles were then used to equate the performance of various groups and schools and an individual improvement of 10% was accepted, as this is the figure used to show a change in grade and is viewed as improvement by the Education Department. (106)

Thus to quantify scissor skills, which as a whole does not include only the end-product, that is how accurately one can cut, but also the method of achieving the task of cutting, it was divided into scissor grip, cutting motion, cutting approach, cutting accuracy and also cutting time. The observations taken during the assessments were further divided according to the shape cut out (square and circle).
It was found that as the tasks became more complex participants tended to revert to more immature patterns of movement. This was observed when they moved to the task of cutting a circle which was more difficult than cutting a square. For the purpose of this discussion, however, observations were analysed as a whole. Generally

improvement was found for all aspects of scissor skills with the exception of cutting time.

The intensity of the program, with 41 work sheets completed in a 10 week period may well account for the significant improvement seen. Participants were exposed to scissor skills on a daily basis which allowed them to benefit from intense input, as they were able build on what was done on the previous day. The program avoided breaks between learning sessions which can slow down the process of acquiring the skill. (37)

Tasks that have been over-learned are less likely to be forgotten than tasks that have barely been acquired. (8) The intensity of the program also allowed enough practice for learning to take place so participants attained an effective level of motor skills. Travis (36) found that when learning a fine motor task, rest periods between tasks are not that important. Different schools of thought are represented in the literature on learning schedules, including massing and spacing during learning of the skill. It was agreed on the whole that massing resulted in greater learning, due to the fact that each performance reinforces any loss from the previous performance, thus it was beneficial for the participants to practice scissor skills on a daily basis in the program. (37)

In order to improve the effectiveness of the program the practice component was done first every day in class, followed by the picture component of the scissor skills program. The practice component was aimed at practicing certain parts of the skills, for instance straight lines only, or corners. It was felt that the practice component was a very important part of developing scissor skills, as it encouraged the same action several times, thus allowing a child to practice and thus learn the task. The picture component was also important, as it was not as monotonous and provided an end-product. Further, in order to complete the picture component successfully, it required the practice component to be completed, as this taught parts or components that were required in that specific picture.

Another benefit of the short time period was that the improvement in scissor skills could be attributed to the program and the effect of many other factors, such as classroom activity or home stimulation could be reduced.

Confidence intervals used to evaluate the effectiveness of intervention indicated that cutting accuracy and consistency developed before velocity. None of the groups in any of the schools showed statistically significant changes in cutting time, even after the intervention. The method in which time was measured could have affected the outcome and possibly the change in time scores could have been underestimated. Nonetheless, velocity develops after accuracy and this supports the theory of skill development where it is detrimental when learning a skill to work too fast, as this compromises accuracy. Consolidation of accuracy and consistency before acceleration and velocity in motor learning is essential. This results in improvement in co-ordinated movements, impacting on efficiency. Practice allows the development of more segment-specific control so that accuracy can be established and a change in movement efficiency is achieved. Less energy is required with a change at a muscular level and attention can then be directed at developing speed. (42)
The cutting accuracy of the participants, in both groups of participants for all schools, improved (Figure 6.2) at the expense of cutting speed. This indicates that scissor skills are not completely consolidated at a Grade 0 level and movement efficiency must still be practiced in Grade 1.
The results may also have been affected by the fact that no emphasis was placed on timing (which was done without participants being aware of it) during the assessment, but rather on the accuracy of cutting on the line.

When looking at skill development, it is also important to take the starting point of the skill into consideration. If the skill is well developed improvement will be limited, whereas if the skill is unknown or little practice of the skill has resulted in skill development being poor, greater improvement can be expected. This was observed in the results where participants with lower scores (School 3) improved significantly compared to those with high scores (School 1 and 2) in the 10 week scissor skills program. (Figure 6.2)

The bigger improvement in scissor skills at School 3 indicated that the skill was not well developed initially. The percentile for cutting accuracy improved from a range of the 9^{th}-29^{th} percentile at baseline to a range of the 72^{nd}-94^{th} percentile after intervention. (Table 6.3)

Results of the parent questionnaire indicated that these participants had not been exposed to as many resources needed to develop this skill, due to their environments. (Table 6.2) It was found in this study, however, that with the correct input they were able to develop this skill in a very short time period. Thus, the participants had the underlying co-ordination required to develop scissor skills; but lacked exposure to the opportunities needed in order to develop the skills. In actual fact, it could be argued that School 3 probably had advanced motor skills, as these participants were generally younger than the participants in the other schools, however, still being able to develop these skills. The results for School 3 were further affected by absenteeism and the problem of non-participation on the teacher's part. The less the children were exposed to the skills, the less they were able to practice. This directly affected the development of skills learnt and children who participated less were not able to consolidate what they had learnt.

The improvement in the cutting accuracy indicated that this aspect of cutting was developed more quickly and to a greater extent than cutting motion or cutting approach. Although these aspects showed statistically significant improvement; the mean percentage improvement was not as great as cutting accuracy (Table 6.4). It is apparent that these aspects of cutting require even more practice to improve before they are consolidated. The scissor grip, a more basic component of scissor skills that positively influences the cutting motion and cutting approach was developed and was reinforced in the initial part of the year, indicating this is an aspect of scissor skills that Grade 0 learners can be expected to achieve.

These findings impact not only occupational therapy but also education and normal development. In terms of occupational therapy, one needs to distinguish which children require therapy due to dysfunction caused by endogenous factors and which children require input due to environmental deprivation. An excessive number of referrals can be prevented, if learners who just need a supportive environment can be identified and helped in the classroom. These results should be made available to the Education Department in terms of the school system and learning they need to impart to scholars. Findings have shown that participants were able to improve significantly (in respect to scissor skills) and possibly other fine motor skills with the correct input. This is in agreement with Dunn et al (2006) who found that if the input at school was effective, it counteracted socio-economic deprivation. They felt the Education Department should use all viable form of intervention to optimise a child's development, especially by providing a sound environment and effective curriculum. (110)

7.2 Change in scissor skills prior to intervention and skill retention

Change in scissor skills prior to intervention was measured by assessing Group B at baseline and then after 10 weeks with no intervention, to establish what improvement had taken place in the classroom over that period. Although the participants in Group B did participate in daily activities and in a curriculum in class this was not enough to result in a statistically significant improvement in their scissor skills.

This was true for the aspects of scissor grip, cutting motion, cutting approach and accuracy during that period (Table 6.6). Cutting time, however, showed a statistically significant improvement in School 1B and School 2B (Figure 6.3) which negatively affected their accuracy score, which decreased by 1% and 2 %. It appeared that the need for the participants to be accurate in cutting was not reinforced during this time, thus they compromised their accuracy for speed. Generally when children are not structured correctly, with the correct grading of the activities in terms of difficulty, it is difficult to enhance the skill and allow for significant learning to take place. (41) It seems that Grade 0 learners often are left to develop their own skills, rather than being shown correct methods. Thus developing their skill may take longer, if they are not initially guided in using the correct motor components and correct scissor manipulation, when cutting with scissors. They may then not practice the skill correctly which will affect both the accuracy as well as speed of work. Learners left to develop their own ‘style’ may use incorrect methods rather than immature methods, thus further slowing down the learning process and often inhibiting them from achieving their full potential. (41)

Often, comments are made about ‘maturation’ of skills. This is a common misconception. The literature suggests that in actual fact there is no improvement of skill, unless there is some form of input in order to achieve this. Thus there is no ‘maturation’ that allows the improvement of skill. Maturation is only seen in growth aspects such as organs and in pre-programmed motor patterns such as walking. (25) Related to maturation is the critical period; here the child is prepared to learn, due to the biological and maturational stage s/he is at, however, s/he requires the correct environmental influence for this to be successful. The optimal period is summarised as that time, when the child most successfully is able to develop a specific behaviour, due to the correct timeous interaction of maturity and stimulation. (25) Basic performance seemed to depend on maturation, whereas the development of skills is dependent on practice. (8)

By assessing Group A after a 12 week period when they had no intervention, (this included the 10 weeks when Group B had intervention and two weeks holidays) the retention of scissor skills without intervention was also considered. Learning brings about change, through practice, and aims to bring about permanent change, although Epstein found that retention is more related to the actual skill achieved, rather than the type of practice used. (37) The retention of learnt skill allows the learning proficiency to be established.

Group A for all three schools retained all aspects of scissor skills learnt in the initial part of the program. Although scissor grip, cutting motion, cutting approach, cutting accuracy and cutting time improved after the intervention had been completed,

(Figure 6.4) only scissor grip for School 3A further improved significantly. This may be because the program in School 3A was extended as it was not completed in time. Their retention time was therefore shorter than for other groups by three weeks. Although the level of initial learning and practice appear to be the most important factor in being able to retain a skill, (8) the rest period between the learning sessions is also important and may have played a role here.

The decrease in cutting time seen at this stage was encouraging as it showed that the scissor skills which were still a classroom activity, allowed the participants to practice more. As they became more confident in their ability, they started working a little faster. One group (School 2A) showed a marginal drop of 3% for cutting motion (Figure 6.4) which was not statistically significant. This was the only group affected negatively by the withdrawal of the program and the result showed no specific trend.

It would be interesting to follow the participants over a longer period, through to Grade 1 to establish whether retention and development is maintained. Various studies indicate a remarkable retention of motor skills after a number of years. According to Freeman and Abernathy, once a skill has been consolidated the learnt skills remains well established compared to recently learnt skills. (40)

In general, participants showed an ability to maintain their level of skill, even after the program had ended. The amount of input provided by the program for scissor skills was enough to develop the skill and also maintain it, without the intense program continuing for the rest of the school year.

7.3 Timing of intervention

The effect of presenting the program at different times in the year was analysed. It was necessary to establish when in the school year an intensive program targeting a specific skill would be most effective. When entering Grade 0, children come from varying backgrounds and therefore also with different skill levels. Within this year, children develop and improve in all areas, resulting in them becoming school ready.

When introducing a program such as this scissor skills program it needs to be established if participants learn more quickly in the latter part of the year, when they have done many other activities and have been prepared for this task, or if they are able to learn this task at the beginning of the year. The maturity of their motor system in terms of the program and the time in the year, needs to be considered in terms of when the learning scissor skills would be most effective.

The results show that Group A benefited from having the program early in the year with their improvement being significantly greater in mean percentages than that of Group B. (Figure 6.5)

It was clear that the timing of the intervention also resulted in improvement in different aspects of scissor skills. The study accommodated for this aspect by providing intervention for Group A in the first part of the year and for Group B later in the year. A limitation of the study however was that timing of intervention and assessments were affected by different holiday schedules. The program was also not completed for School 3A, and the teacher had to be given extra time to complete the program before the participants could be re-assessed. Not all participants could be re-assessed at the later point in time due to absenteeism as a result of bad weather, thus possibly advantaging those who had time to complete the program.

It was found that scissor grip improved significantly in the initial intervention phase (Group A) for all schools, showing that this input is vital in showing participants the correct way to hold the tool at the beginning of the program. This skill already seems to have been consolidated in the later intervention phase (Group B) where no significant improvement was seen. (Table 6.4)

Both groups showed statistically significant improvement in the ability to manipulate the scissors, resulting in correct cutting motion. This aspect continued to improve with practice throughout the year, indicating an improvement in controlled cutting and rhythmical and smooth scissor closure. Similar results were found for cutting approach with consolidation of the way to cut around a shape or how to cut corners. Cutting accuracy improved statistically more in the later intervention (Group B). It is possible that the development of accuracy is dependent of the consolidation of the scissor grip as well as other factors like age, the ability to focus on a task and the development of norms in terms of producing an acceptable end product. (13)

The significant improvement for accuracy in the initial intervention found for School 3A was related to their low initial scores. This indicates that accuracy improves to a greater extent in participants who present with a significant lack of skill initially. (Figure 6.7)

The three aspects in which Group B improved more (cutting approach, cutting accuracy as well as cutting time) than Group A was for School 2. (Figure 6.5) This could possibly be attributed to the combination of participants in that class, as well as teacher input. This class seemed to have developed good skills overall, as a result of an observant and knowledgeable teacher, and participants that were able to benefit from the correct input, a variable that could not be controlled in the study.

The pre-school year is seen as one unit and is not further sub-divided into smaller parts. Skills are expected to develop throughout the year, so that at the end, the participants are school ready. (28) It was concluded that participants benefited more from participating in the scissor skills program at the beginning of the year, indicating their motor skills were developed enough at this stage to deal with this task. These participants were also able to retain their scissor skills and started to improve their cutting speed by the later part of the year. Cratty in his summary of studies done on motor performance indicates that gross motor skills tend to be more dependent on maturation, whereas fine motor skills are more dependent on the learning experiences. (8)

7.4 Equivalence

One objective of this study was to establish how similar participants were in terms of functioning in scissor skills at the end of the intervention. All groups received the same intervention program with the view of changing their skill levels to possibly achieve similar skill levels in their Grade 0 year.

At baseline assessment there was no significant difference between Group A and B in scissor skills in each school except in School 2 where scores for Group B were better for scissor grip and cutting motion. (Table 6.12) However, the three schools presented with different skill levels. This was not unexpected as after the first year, in which development is programmed and children reach their motor milestones at more or less the same time, variability increases. By the time children start school, their skills vary tremendously because of

> "differences in environmental opportunities, familial and cultural influences, personal experiences, and genetic endowment." (63 pg 333)

The differences found at baseline assessment 1 between the participants from the three schools, represent the effect of socio-economic factors in South Africa on learners entering Grade 0. Participants from a higher socio-economic background in School 2 performed best in terms of medians of percentiles for accuracy and all aspects of scissor skills at baseline (6.3 and 6.12).
Participants at School 1 presented with medians of percentiles for accuracy and scores for the five aspects of scissor skills that were slightly lower than School 2, but the few statistically significant differences showed no definite trend. In the 20 comparisons made between scores for scissor skills in Group A and B in School 1 and 2, School 1 had significantly lower scores for seven aspects. (Table 6.12)

The scores obtained by School 3 were of the most concern as they were significantly lower than those for Schools 1 and 2 in most aspects of scissor skills. The scores were significantly lower for 15 out of 20 aspects of scissor skills when compared to

School 1 and for 16 out 20 aspects of scissor skills when compared to School 2. (Table 6.12)

Their scores for accuracy ranged between the 9th and 29th medians of percentiles compared to the range of the 62nd to 100th medians of percentiles obtained by the other two schools.
Participants in School 3 obtained the greatest change in percentile ranks (49-90) for accuracy in cutting when compared to the changes in School 2 (0-9) and School 1 (6 - 29).

The rate of improvement varied among the three schools. School 3 showed the greatest rate of improvement for cutting accuracy by far. Further, they also showed the greatest improvement in cutting approach and School 3B in cutting motion. However, for the three schools to have become equivalent at the end of intervention, the rate of improvement of School 3 should have been marked in all areas, in order to close the gap towards the other schools, that started with higher initial scores. (Figure 6.7)

The percentage scores for participants in School 3A were still statistically significantly lower than School 1 and 2 for most aspects after intervention. Only cutting accuracy was not significantly lower for School 3A. This group had been disadvantaged by the teacher not completing the program. This was evident, even though she was given extra time as not all picture books and practice sections were returned to the researcher. (Table 5.4)
School 3B still lagged behind Schools 1 and 2 significantly for all aspects of cutting skills except cutting motion by the end of the program. In terms of mean percentages, School 3B was able to close the gap towards School 1B, scoring within 10% of them (Figure 6.6).
In terms of cutting time, the gap needs to be even smaller, as a 10% difference in speed of work is still a big difference. 10% represents 18 seconds and there were

many children that were able to complete the whole task in 12 seconds. However, a difference of 10% in for example accuracy is acceptable.

Results confirm that the participants at School 3 were able to partially close this gap in ability over a 10 week intensive class based program (Table 6.3) and achieve accuracy medians of percentiles and percentages for some aspects of scissor skills, closer to those achieved in the other schools. In order for School 3 to close the gap completely participants should have improved more rapidly than the other two schools. Statistically, they were able to do this for some aspects; but this increase in rate of skill development was not enough to close the gap in all aspects of scissor skills, towards all of the groups. This leaves us with the question, whether the difficulty in achieving this was with the educator, rather than the participants.

When looking at closing the gap, one needs to consider resources that are available to teachers. In this case, teachers were given all the equipment required in order to develop this skill. They were also given guidelines on what was expected. However, the results show that instructions and guidelines should have been even more detailed and although support by the researcher was given at regular interval, it was obvious that teachers at School 3 required more support. For instance, the problem of participants not cutting on the line but rather cutting the general outline should have been corrected by the teacher on the first instance, thus teaching the skill of cutting on the line. This, however, was not done, either because it was not observed, or because the teacher was unaware that this is not the way to teach this skill.

Thus in order to close the gap, the teacher needs to be able to impart the correct skills to the learners. She needs to be aware of requirements and she needs to have the equipment readily available to her in order to do this efficiently and within the correct time frame. The learners have the correct motor co-ordination basis; it is up to the educators to provide the stimulation and exposure required in order to develop the skills.

There was a loss of over 50% in both picture books as well as practice components from School 3 (Table 5.4). It is not possible to establish if the program was completed, whether it was presented inconsistently or if the collection of the material was too complex or time consuming for the teacher. Absenteeism was another compounding factor in School 3 where participants often walked to school and this as well as lack of heating at school resulted in weather dependant attendance.
Thus even though the circumstances in which the program for School 3 were not as favourable, the participants still managed to improve their skill levels and in some instances close the gap towards their counterparts in School 1 and 2. Had variables like teacher guidance, co-operation and teacher and student absenteeism not interfered, an even greater improvement may have been achieved. Lastly, the study also showed that individual teachers also affected the performance of the participants through knowledge, motivation and also personal health.

Factors affecting school readiness are multi-faceted; a child's development is affected by many different aspects such as birth weight, general health and diet, nursery schools attended and their quality, parental input such as speaking to one's child, reading to them, stress levels in the home etc. Many factors are not measurable. (92) In this study, it became obvious that school and home environments affected participants' performances. Some participants in School 3 were able to cut accurately on a straight line at baseline assessment 1. Thus, as many others were not able to do this, it is assumed that these children had learnt that skill at nursery school or at home. The parent questionnaire also confirmed this, indicating that 66% had attended nursery school and 82% had scissors available at home (Table 6.2). It was possible that 18% of these participants had never used scissors before compared to 0% at School 2 and 2% at School 1. It was also obvious that they had had less guidance and practice in cutting with scissors.
This indicates the importance of developing skills at an age appropriate level. This finding is supported by Rouse, Brook-Gunn and McLanahan who confirmed that gaps found in high school students are already present when children start school. (28)

This means that children who enter school without being school ready (either with social, emotional or academic deficits) carry their problems with them.

Two studies completed on children in South Africa emphasised the importance of early exposure to fine motor activities. Ratcliffe suggested that cutting with scissors should be started as soon as possible to eliminate difference in skill found between the children, irrespective of their background and opportunity. This would enable children to start off on a similar level in Grade 1, rather than disadvantaged children having to close gaps in basic task requirements, that are due to adverse environmental conditions. (5) This is supported by the recommendations of Verdonck and Henneberg which state that

> "Intervention at a community level should take place as early in the lives of children as possible. Providing children of poor socio-economic backgrounds with simple task-oriented activity programs that can be implemented by parents or nursery or primary school teachers may improve fine co-ordination." (27 pg 306)

The school environment also affected the skill level similarities in the groups at each school indicating that the classes were doing similar tasks. There was a disparity between schools in terms of the amount of application of teaching materials, resources and learner to teacher ratios.

The second major factor to consider in closing the gap between the scissor skills of the participants at the three schools was the ability of the participants themselves to improve their skills.
In this study the substantial age difference between participants in School 3B and the other schools appears to have more of an effect after the implementation of the scissor skills program. The final scores after the intervention indicate that age limited this group at School 3, as they achieved the lowest medians of percentiles after the implementation of the program. This reflects the inability to achieve accuracy in cutting at an age 7-12 months lower than other participants.

These results indicate these younger children could possibly benefit from another year in Grade 0, as at the end of the year they were approximating the level achieved by the participants from the other schools at the beginning of the year. This is further supported by other studies that have found that children are not able to close gaps throughout their school career and thus it would be important to try to close the gap at the very beginning. (27)

The study proved this approach to be effective as participants from all schools but particularly School 3 benefited from the scissor skills program. It also indicates that children in South Africa are not functioning on a similar level towards the end of Grade 0, before entering Grade 1. Factors affecting the level of skill have been discussed and the intake of all children from differing backgrounds into Grade 0 is complex in every aspect. Children enter with different sets of skills and the aim is to move all children along the continuum of development so they complete the Grade 0 year on a similar point on the continuum. (43) Since this is not happening in terms of scissor skill development at least, some strategic planning in terms of correct and concise input is needed.

Increasing the level of functioning of children in Grade 0 in South Africa, would be beneficial, not only to the individual but also to the population in general. How would one do this? One aspect would include the exposure of children to high-quality educational programs. (28) To progress we need to provide opportunities for children to learn and develop; this, not by decreasing the standard, but rather by improving our services and giving each child the means to progress. (5)

7.5 Change in Bilateral Fine Motor Skills

The assessment of other fine motor tasks in all groups of participants before and after the intervention period, in which they practiced scissor skills, showed a trend of slight improvement in mean percentages. There were a few scattered, statistically significant improvements over the various groups at the different schools. However, there was no trend indicating transfer from the scissor skills into the other bilateral items (Figures 6.8 and 6.9). The improvement seen in the other tasks used in the assessment of bilateral fine motor skills was probably related to the fact that these activities are done in some Grade 0 classes. In order for the improvement in skill to be attributed, however, to transfer from the scissor skill program, where input was given intensely over several weeks, one would expect to see a significant improvement in the other bilateral fine motor skills. A significant improvement directly after implementation of the program would be expected which correlated to the improvement of scissor skills in all three schools. Since this was not found it was accepted that there was no transfer of the cutting skill into any other bilateral aspects tested.

This is because transferability depends on practicing the specific activity as well as the individual's ability. This allows motor engrams as described by Lashley (70) as motor movements, through learning, to become stored in the central nervous system. It is important to note that motor engrams have been attained by the individual through practice and feedback loops, while performing the task, rather than through developmental processes. (71)

It is felt that if intertask transfers are to be observed, emphasis should then be on those components that are actually similar. This supports the findings of Cratty who states that positive transfer does occur between tasks but only if they are similar and especially where the same motor response is required. (8, 43)

In terms of bilateral tasks, all of them required the asymmetrical involvement of the non-dominant hand, to a greater or lesser extent. For instance, drawing around an object requires more involvement of the non-dominant hand, not as much as in cutting, but still active involvement. For intertask transfer to take place, it is felt that emphasis would have to be placed on this non-dominant hand; if this is made more overt when learning takes place, participants are more aware of it and one can build on that to develop another skill. For drawing around an object, School 1A and School 2A showed significant improvement. For tearing on a line, School 3A and School 1B showed statistically significant improvement. And lastly, for threading, School 2B showed significant improvement (Table 6.17 and 6.18). Thus, without emphasis on these bilateral skills, there is no carry-over occurring naturally to other tasks. School 3B showed no significant improvement.

Environmental factors seem to support the participants' significantly higher scores in some aspects like tying shoelaces. During the assessment it was noted that all of the participants at School 3 were wearing school shoes with laces, indicating that they were exposed to tying their own laces. Participants at School 1 often wore shoes with Velcro or sandals.

At School 3 participants also matched the performance of participants at School 1 in closing buttons as they were all wearing school shirts with buttons, thus also being exposed to that skill. All participants in School 1 were wearing T-shirts at the time of assessment 1.

Thus exposure to a skill, irrespective of socio-economic status due to the clothing they wore and the expectation that they dress themselves, meant that participants achieved the task at an acceptable level.

Improvement in the fine motor skills found during the period of the study was attributed to normal development in the classroom. Over the period of the research, the participants were benefiting from some type of bilateral fine motor skills input, which should be measurable. The general trend (70% of measurements) is that of non-significant improvement over the three assessments for bilateral fine motor skills other than scissor skills (Table 6.17 and 6.18). This means that if these tasks are done in class there may not be much emphasis on specific motor patterns to be used. When looking at tearing, children are possibly asked to tear for example tissue paper for a creative activity. This is not very controlled and although it exposes the learners to tearing, it does not improve their ability to tear on a line. An improvement in bilateral fine motor skills, when they are under-developed, depends on educators' ability to analyse the activity as this would allow them to be able to focus on correctly guiding individual aspects of specific skills. If a skill is taught in-depth, one can expect a bigger improvement, especially if the starting point is weak.

Some areas show a marked improvement in skill. This indicates that learning has taken place and children have learnt the skill and thus are also more consistent in their responses. Statistically significant improvement (Table 6.17 and 6.18) was greatest in School 1, where teachers possibly use more standard tasks to improve these skills than the other schools, thus achieving the best result.
In general, there was not much improvement for writing the name. In School 1 and School 2, children were able to write their names from the beginning of the year, thus many children probably were able to do this before entering their Grade 0 year. Participants at School 3 had limited exposure to writing the name at the end of the Grade 0 year only and there seemed to be little preparation for the learning-to-write process in Grade 1. Although the participants in School 3 scored similarly to the other participants, they were measured on drawing circles, rather than writing their names. Thus, their skill level of writing the name was not as advanced as the skill of children in the other schools and not comparable in terms of letters.

The task of buttoning showed little improvement; however, all participants in all three schools generally were able to do this. Only participants in Schools 1B and 2B improved significantly in the task of threading, although beads and string was seen in all classes and thus children had been exposed to this. Both drawing around an object and tearing showed two groups with statistically significant improvement. These tasks were probably included in the curriculum e.g. using stencils to improve drawing around an object and tearing tasks, such as tearing a shape or a certain sized paper for creative activities.
Tying shoelaces improved the most overall, with three groups showing statistically significant improvement. This is a task that generally develops in Grade 0. It is also a task that can be monitored, as learners are involved in sports at schools and thus often have to take off shoes and put them on again, thus improving their ability to tie laces.

Changes to be made to the bilateral fine motor skills assessment after use in the study include the item of writing on a line. With not all of the children in Grade 0 being exposed to writing, the assessment could possibly include the aspect of colouring, rather than writing. Through the item colouring in, one could also observe pencil grip, pressure of drawing, fine motor control and approach to the task, such as colouring in one direction, staying within boundaries, covering the whole surface area and stabilising as well as manipulating the paper with the non-dominant hand.

7.6 Program Evaluation

The scissor skills program was evaluated in a number of ways to establish its effectiveness and what changes needed to be made.

The program used in this study proved that it was effective. However, a number of factors must be considered that could in future make it more effective.
The lack of maturity and readiness in terms of skill in the participants in School 3 became evident. Participants would have benefited from a pre-scissor skills program, teaching actual tool use first by cutting other materials like play dough to prepare them adequately for the input presented in this program. This would raise their skills to a level where they could really benefit.

A limitation of the study included working with different teachers. The teacher training on the program was done before commencement of the scissor skills program, and aimed at assisting the teachers in their observational skills. As teachers have different backgrounds themselves, including training as well as years of experience, this also impacts on their ability to carry out the program effectively, with the best results. The teacher training aimed at minimising these differences. When analysing the practice and picture components of the program, however, it became clear that for the program to be really beneficial in all classrooms, even more emphasis should be placed on specific training on carrying out the program and educating teachers on the importance of the development of fine motor skills.
Many participants cut the general outline of a picture, rather than on the actual line. Teachers should have been able to correct this if it occurred more than once, in order

to develop this skill correctly. In School 3, however, this was not done and the problem of cutting around the pictures was observed as an ongoing problem meaning that participants practised the incorrect skill. Had this been corrected immediately, it would have also affected the scores obtained by School 3. Thus it was clear that some teachers needed more training and support to initiate and complete the program timeously and correctly.

Child development is not only dependent on children and their ability to learn and develop skills but is also affected by teacher input. Important qualitative factors for child development include not only a program structure, but also processes such as warmth and responsiveness of a caregiver and also emotional tone of the setting. (26) The atmosphere in the classroom and the approach used by the teachers in presenting the program was not controlled for in any way during this study, but supporting teachers in the presentation or the program may also need to be considered with some teachers.

Barrow and McGee state that measurement should be applied to the product as well as the process. (60) They describe the importance of evaluating the product, here the skill level of the individuals, as well as the process, in this case the program components and cutting skills on completion of the program. Thus both the practice skills and pictures were evaluated to establish the effectiveness of the program.

In the analysis of the practice component the mean percentage scores obtained by the participants were generally good. School 1 and 2 scored most of the practice components above 70%. School 3 scored lower than School 1 and 2, with Group B having more than half below 50% (Figure 6.11). A limitation of the study, however, was that logistically in terms of collection in the classroom it was only possible to assess the initial page of each new pattern. This meant that only 3 mm lines were evaluated; and these may have been easier to cut than the following pages, which included thinner lines affecting the results.

In a previous study, it was found that children struggled the most when cutting out circles. (5) In this research, this was the case again, and five of the six groups in this study had the lowest mean percentage scores for the circles. This indicates the level at which Grade 0 learners can be expected to perform and that further practice in cutting a circle needs to occur in Grade 1. Mean percentage scores and also medians of percentiles, however, indicate that the level of difficulty of this task can be expected from Grade 0 learners.

The pictures that were analysed were cut out and pasted into a book to be handed in after the participants had completed the practice component. Most groups had the highest scores for the straight-line designs. These were between 40% and 80% for School 1 and School 2. (Figure 6.12) The program was graded in terms of difficulty. Thus the initial shapes were mainly straight lines only and they were easier to cut out. This was reflected in School 1 and School 2, who had the ability to cut on straight lines with up to 95% accuracy. School 3 had not really developed this skill and scored between 17 and 34% for the straight lines. (Figure 6.12)
The results indicate that many participants were not able to cut accurately on the picture lines. The picture component of the program thus needs to be adjusted. While scoring the participants pictures, common mistakes were highlighted on a sample picture. These results will be used to make changes to the pictures and thus adjust the level of difficulty.

Most participants scored below 50% for the pictures without straight-line designs (Figure 6.12). This did not correlate with the practice component, where participants performed much better. A number of factors may account for this result. The picture component was done in the same classroom session, after the practice component was complete, when fatigue may have been a factor. Participants could possibly have concentrated better and worked more carefully in the practice sessions. The symmetrical nature of the practice component made it less complex than the picture component. The line thickness in the practice session did not vary as much and were thicker making cutting accurately on the line easier.

Teachers' perceptions of the program were also included in the evaluation. Verbal feedback was obtained and all teachers were asked to fill out the teacher questionnaire. (Appendix V)

It was felt that the teacher's perception of the program played an important role in teaching the skill. The comment by the teacher from School 3A about the fact that she felt the program was too difficult indicates that she expects less from the learners in her class. Here for instance, children may not be encouraged to cut on the line, as the teacher herself feels that that requirement is too difficult. She may have felt that cutting the general outline is good enough for Grade 0 pupils and thus decided not to correct this.

Teachers from School 2 and School 3 felt that the program was too intense. This could possibly have affected the motivation of the teachers in School 3, who felt it was too much to do and thus did not complete the program with their learners. This could be seen by School 3 A, that required extra time to complete the program and also by both Group A and Group B by not handing in many practice and picture components of the program. Teachers from School 2 may have understood the importance of completing the program, although feeling that it was too much to do.

One of the teachers in School 1 commented that the program did not cut down on preparation time currently; however, she felt that if they were using it as standard procedure in their Grade 0 curriculum and if she had the assurance that it developed the skills adequately, she would not have to prepare own activities in order to develop the scissor skills. Then it would cut down on her preparation time.

The changes to improve the effectiveness of the program include the following:

- a pre-cutting section should be added for those participants who are functioning below the 50th percentile initially.
- adjustments should be made to the picture section in terms of line thickness and the complexity of the designs that are not straight line designs.
- cutting time did not show marked improvement throughout the schools and possibly this variable should be only be addressed in Grade 1.

- a more detailed teacher description of what exactly is required should be included. This should be done step-by-step, with the actual running of the program, so that for instance, curves are mentioned only when they get to that aspect of the program. This would eliminate too much information initially, thus the educator being able to grow with the program.
- trouble-shooting should be discussed with the teachers as many difficulties were noted when analyzing the samples that were returned by the teachers and these could be used as examples, for correct implementation.
- a section on how to solve problems or how to correct common problems needs to be included in the teachers training.
- support for those teachers who are finding it difficult to implement the program initially should be available.
- teacher feedback included that using the program every day was too often. It would be recommended, to carry out the program twice per week, thus extending the period over which it runs. This would allow the teacher to address the different aspects of scissor skills, focusing on them in different parts of the year and thus achieving maximum skill development.

7.7 Summary

In summary, the development of scissor skills requires the correct input and the opportunity to practice. This can be achieved by a dedicated program, which has proved to develop the skill within a certain time frame. Participants with the lowest initial scores in scissor skills were able to show the greatest improvement, especially in the easier motor aspects of the task. Although the participants from a low socio-economic area closed the gap in relation to other more socio-economically advantaged participants, they were still functioning at a significantly lower level at the end of the intervention. In order for them to completely close the gap, they should have improved more rapidly than the other schools.

Introduction of the program early in the year benefited participants more. Than later in the year.

There was no transfer of bilateral fine motor skill from one practiced task of cutting with scissors to others, which were not practiced specifically.

Different variables affect the outcome of the program. These include the school environment including the teacher (knowledge, experience, motivation and health) as well as the resources available to her. Further, the effectiveness of the program is also affected by the access of the participants to the program, which was reduced by absenteeism of the participants or the teacher herself, as well as the program not being administered completely.

The program was effective in improving scissor skills significantly in Grade 0 learners. Changes, including a pre-scissor skills section as well as adjustment to the picture component, would improve the quality of the program.

Lastly, as there was improvement in various aspects throughout the year, as well as the fact that five times per week seemed too much for most teachers, it would be recommended to carry out the program twice per week, thus prolonging the time of the intervention. This would allow the teacher to address the different aspects of scissor skills, focusing on them in different parts of the year and thus achieving maximum skill development.

The Education Department has set a goal of learners participating in an accredited Grade 0 program by 2010. This scissor skills program has shown the type of impact one can expect from a dedicated graded program, developed specifically for that age group.

8. CONCLUSION – CHAPTER 8

8.1 Summary

The bilateral fine motor skills of Grade 0 learners from three schools in different socio-economic environments in Johannesburg in South Africa were assessed. All learners participated in a scissor skills program run by their class teachers at different times in the year.
The objectives set at the beginning of the study were met and are discussed as follows.

An assessment for bilateral skills was developed in order to measure starting points in bilateral activities of children in Grade 0. The assessment was task-based, i.e. activities were selected that included a wide variety of bilateral tasks that children generally do in Grade 0. The assessment was validated and proven reliable during the pilot studies conducted at different schools.
The next step of the research included the development of a scissor skills program that was implemented by the class teachers over 41 sessions. This program was validated by a focus group of 12 experienced occupational therapists. It was then revised and drawn up by a graphic artist, so that children would enjoy using the end product.
Results of the assessment showed that all children improved their skills including scissor grip, cutting motion, cutting approach and accuracy. Cutting speed varied amongst the groups; however, this aspect was not reinforced during the program. Participants from lower socio-economic groups showed the greatest improvement and they managed to decrease the gap in skill level towards their counterparts for some aspects, by scoring within 10% mean percentage of their skill level in some cases. The study further showed that children were generally able to retain their skills, even once the program was completed and there had been a time lapse of three months. Participants seemed to have benefited more from having been presented with the program at the beginning of the year. When looking at cutting skills, there was no transfer of skills from this bilateral activity to the next.

Results of the program showed that there were participants in Grade 0 that had the ability to complete the SASSP with 95% accuracy at the top range of the ability-spectrum. There were, however, also many children who tended to cut with less than 50% accuracy. There also seemed to be a discrepancy between the two program sections, with the practice component being done much better than the picture component.

8.2 Recommendations

This includes:

- the further development of the bilateral task-based assessment. This entails the development of precise norms by including a much larger sample of children and analysing cutting skills according to the difficulty of the shape. The item of writing the name could be replaced by a colouring task. Further, the use of a composite score is recommended. The development of the bilateral skills assessment with norms is recommended so that therapists can use this in their clinical practice.

- the adjustment of the scissor skills program. The picture component of the program can be made a little easier, adjusting the line thickness. This will allow more of the children to cut with more accuracy along the lines.

- the modification of teacher instructions, including slightly more detail as to what skills one can expect from the children in Grade 0 and initial support for some teachers in implementing the program.

- the implementation of this program in schools in South Africa, that do not have this type of resource. For these schools, the program can further be adjusted, to cover other fine motor skills such as colouring in, tearing and writing their names. In addition, a pre-cutting section would be included.

8.3 Implications of the study

Learners in the South African context come from very different backgrounds. We also know that they enter Grade 1 with very different skill levels. These can be attributed to their socio-economic environments amongst other things. (13, 28, 63) This study has shown that it is possible to start closing the gap in fine motor skills, specifically scissor skills that exist between children from different socioeconomic environments. The use of the correct materials and methods, to teach children in an intensive properly graded program, has shown that skills do develop and previous deficits can be eliminated to some extent. Thus, unless there is some form of specific input, skills that are deficient in terms of school readiness, will not just mature by attending Grade 0 and the gap that exists in these skills will just increase as the child moves though their school career. (28)

The South African Education System has recognised their responsibility in developing the skills of children entering their school systems. The introduction of Grade R into the national education policy is making an attempt to address the problem. (109) However this study shows clearly that socioeconomic status affects fine motor skill levels and the gap in these skill levels needs to be addressed, not by decreasing expectations, but rather by providing the correct input. This could be achieved through the introduction of specific programs that are graded, in order to develop skills and also allow children to carry out tasks often enough, so that learning takes place and so that they are able to retain skills learnt.

Individual teachers need to be trained and supported in the implementation of these programs but for them to be successful the teachers need to be able to access correct resources to use in their classes.

The presentation of this research to the Department of Education Early Childhood Development section and those responsible for the implementation of the curriculum and training of teachers for this level needs to be followed up.

8.4 Future research

This would include monitoring of the scissor skills program in Grade 0 classes in the South African School system. A pre-cutting program needs to be developed with the possibility of school based occupational therapists being involved in the assessment of Grade 0 children to identify those who would benefit from this program.

REFERENCES

(1) Hagedorn R. Occupational Therapy Perspectives and Processes. New York: Pearson Professional Limited, 1995.

(2) Pratt PN, Allen AS. Occupational Therapy for Children. 2nd ed. Toronto: The C.V. Mosby Company, 1989.

(3) Erhardt DP. Development of Hand Preference Assessment. Pennsylvania: Poster Presentation American Occupational Therapy Association Congress; 2001.

(4) MySchool OnlineTeam. "Family Education Network." 2006. <www.myschoolonline.com/page/0> [Accessed 11 Nov 2006].

(5) Ratcliffe I, Concha M, Franzsen D. Analysis of cutting skills in four to six year olds attending nursery schools in Johannesburg. S Afr J of Occup Ther 2007;37(1):4-9.

(6) Levine KJ. Fine Motor Dysfunction-Therapeutic Strategies in the Classroom. Arizona: Therapy Skill Builders, 1991.

(7) Doherty G. Zero to Six: The Basis for School Readiness. Applied Research Branch, Human Resources Development, Canada. 1997.

(8) Cratty BJ. Movement Behaviour and Motor Learning. 2nd ed. USA: Lea and Febiger, 1967.

(9) Galley PM, Forster AL. Human Movement. UK: Longman Group, 1995.

(10) Herbert M. Typical and Atypical Development. Great Britain: Blackwell Publishing, 2003.

(11) Branford W, Thompson D editors. The South African Pocket Oxford Dictionary. 2nd ed. Cape Town: Oxford University Press, 1994.

(12) Radomski MV, Trombly CA. Occupational Therapy for Physical Dysfunction:Comprehensive Atlas. 6th ed. Lippincott: Williams & Wilkins, 2007.

(13) Case-Smith J. Occupational Therapy for Children. 4th ed. St Louis, USA: Mosby, 2001.

(14) Packard, Kauffman and Ford Foundation. "Getting Ready" 2005. http://www.gettingready.org/matriarch/MultiPiecePage.asp_Q_PageID_E_318_A_PageName_E_NationalSchoolReadinessIndicat> [Accessed 5 Oct 2009].

(15) Skill-Builders. "Cutting & Scissors" 2002. <http://www.skillbuildersonline.com/SBA/Index.asp.> [Accessed 2 Aug 2004].

(16) Buxamusa L, Mahoney A. "Ready for Kindergarten: Fine Motor Activities" 1999 <http://www.education.com/reference/article/Ref_Ready_Fine_Motor/> [Accessed 22 Sept 2004].

(17) Kennedy L. "Fine Motor Skills." 2007. <http://home.earthlink.net/~lmlk/id2.html> [Accessed 7 Oct 2009].

(18) Holle B. Motor development in children: Normal and retarded. London: Blackwell Scientific Publications, 1981.

(19) Petrone F. Perceptual motor skills. In The developmental kindergarten. 1976.

(20) Schneck C, Battaglia C. Developing Scissor Skills in Young Children. USA: American Occupational Therapy Association, 1992.

(21) Bruininsk RH. Bruininsk-Oseretsky Test of Motor Proficiency. California, USA: Western Psychological Services, 1978.

(22) Henderson SE, Sugden DA. Movement Assessment Battery for Children. Kent, UK: The Psychological Corporation, 1992.

(23) AMPS Project. "Project International School Assessment of Motor and Process Skills." 2005. <http://www.ampsintl.com/SchoolAMPS.htm.> [Accessed 26 June 2008].

(24) World Health Organisation. ICF International Classification of Functioning, Disability and Health. Short Version. World Health Organisation, Geneva. 2001.

(25) Louw DA, van Ede DM, Louw AE. Human Development. 2nd ed. South Africa: Kagiso, 1998.

(26) Engle PL, Black MM, Behrman JR, de Mello MC, Gertler PJ, Kapiriri L, Martorell R, Young ME, and the International Child Development Steering Group†. "Child Development in developing countries 3. Strategies to avoid the

loss of developmental potential in more than 200 million children in the developing world." 2007. < www.thelancet.com.> [Accessed 15 Sept 2008].

(27) Verdonck MC, Henneberg M. Manual Dexterity of South African Children Growing in Contrasting Socioeconomic Conditions Amer J of Occup Ther 1997;51(4):303-306.

(28) Rouse C., Brooks-Gunn J., McLanahan S. School Readiness: Closing Racial and Ethnic Gaps. Introducing the Issue. The Future of Children. Princeton-Harvard Woodrow Wilson School of Public Health. 2005;15(1):5 -14

(29) Fitt M, Posner MI. Human Performance. 1967 <http://moon.ouhsc.edu/dthompso/mtrlrng/stages.htm> [Accessed 12 June 2003].

(30) Freud S. Standard Edition of the Complete Psychological Works of Sigmund Freud. London: Hogarth, 1966.

(31) Erikson EH. Childhood and Society. 2nd ed. New York: W.W.Norton, 1964.

(32) Maslow AH. Toward a Psychology of Being. Princeton: Van Nostrand, 1968.

(33) Piaget J. Psychology and Epistemology: Towards a Theory of Knowledge. New York: The Viking Press, 1971.

(34) Vygotsky LSICM, John-Streiner V, Scribner S, Souberman E. Mind in Society: The Development of Higher Mental Processes. Cambridge: Harvard University Press, 1978.

(35) Chambers M, Sugden D. Early Years Movement Skills. England: Whurr Publishers, 2006.

(36) Travis LE Practice Factors, Learning and Retention. In Movement Behaviour and Motor Learning. 2nd ed. Philadelphia: Lea & Febiger, 1967.

(37) Connor FP, Williamson G, Gan SJM. Movement. Program guide for Infants and Toddlers. New York: College Press, 1978.

(38) McCraw LW Quantification of Learning. In Movement Behaviour and Motor Learning. 2nd ed. Philadelphia: Lea & Febiger, 1967.

(39) Ehrlich G Perceptual-Motor Learning, Based upon Performance Measures. In Movement Behaviour and Motor Learning. 2nd ed. Philadelphia: Lea & Febiger, 1967.

(40) Freeman G, Abernathy R Practice Factors, Learning and Retention. In Movement Behaviour and Motor Learning. 2nd ed. Philadelphia: Lea & Febiger, 1967.

(41) Gartland S. Occupational Therapy in Preschool and Childcare Settings. In Case Smith J. Occupational Therapy for Children. 4th ed. St.Louis, Missouri: Mosby Inc, 2001.

(42) Marteniuk R, Romanow S. Human Movement Organization and Learning. In Motor Learning Concepts and Applications 4th ed. Brown and Benchmark,1993.

(43) Magill RA. Motor Learning Concepts and Applications. 4th ed. USA: Brown and Benchmark, 1993.

(44) Weiss MW, Flatt AE. Functional Evaluation of the congenitally anomalous hand. Part II. Amer J of Occup Ther 1971;25:139-143.

(45) Fagard J, Marks A. Unimanual and Bimanual tasks and the Assessment of Handedness in Toddlers. Developmental Science 2000; 3(2):137 - 147.

(46) Exner CE. Development of Hand Skills. In Occupational Therapy for Children. 4th ed. USA: Mosby, 2001.

(47) Ramsey DS, Weber S. Infants' Hand Preference in a task involving complementary roles for the two hands. Child Development 1986; 57(2):300-307.

(48) Landy JM, Burridge KR. Ready-to-Use Fine Motor Skills & Handwriting Activities for Young Children. The Center for Applied Research and Education, 1999.

(49) Williams HG. Perceptual and motor development. Englewood Cliffs: NJ Prentice Hall, 1983.

(50) Keogh J, Sugden D. Movement Skill Development. New York: Macmillan, 1985.

(51) Fisher AG, Murray EA, Bundy AC. Sensory Integration, Theory and Practice. Philadelphia: FA Davis Company, 1991.

(52) Gesell A. The first five years of life, A guide to the study of the pre-school child. Great Britain: Butler and Tanner, 1976.

(53) Gesell A, Ames LB. The Development of Handedness. Journal of Genetic Psychology 1947;70:155-175.

(54) Flament F. Coordination et prevalence manuelle chez le nourisson. Paris: Edition du Centre National de la Recherche Scientifique, 1975.

(55) Carlson DF, Harris LJ. Development of the infant's hand preference for visually direct reaching. Infant Mental Health Journal 1985;6(3):158-172.

(56) Thelen E, Corbetta D, Spencer JP. Development of reaching during the first year: Role of movement speed. Journal of Experimental Psychology: Human Perception and Performance 1996;22(5):1059-1076.

(57) McCormick CM, Maurer DM. Unimanual hand preferences in 6-month-olds: Consistency and relation to familial-handedness. Infant Behavior and Development 1988;11(1):21-29.

(58) Ozturk C, Durmazlar N. Hand and Eye Preference in Normal Preschool Children. Clinical Pediatrics 1999 Nov;38(11):677 - 680.

(59) Devlin B. "Developing Scissor Skills." 2001 <www.neelb.org.uk/cass/earlyyears/downloads/Developing%20Scissor%20Skills.pdf.> [Accessed 4 June 2004]

(60) Barrow HM, McGee R. A practical Approach to Measurement in Physical Education. USA: Lea and Febiger, 1971.

(61) McClenaghan BA, Gallahue DL. Fundamental Movement: A Developmental and Remedial Approach. USA: WB Saunders Company, 1978.

(62) Ayres AJ. Sensory Integration and Praxis Tests. Los Angeles: Western Psychological Services, 1989.

(63) Parham LD, Mailloux Z. Sensory Integration. Occupational Therapy for Children. 4th ed. St Louis, USA: Mosby, 2001.

(64) Piper MC, Darrah J. Motor Assessment of the Developing Infant. Philadelphia: WB Saunders, 1994.

(65) Gentile AM. Implicit and explicit processes during acquisition of functional skills. Scand J of Occup Ther 1998;5 (1):7-16.

(66) Colley AM, Beech JR. Acquisition and Performance of Cognitive Skills. New York: John Wiley and Sons, 1989.

(67) Adams JA. A closed-loop theory of motor learning. J of Motor Behavior 1971;3:111-149.

(68) Sugden DA, Sugden L. The assessment and management of movement skill problems. Leeds: School of Education, 1990.

(69) Anderson JR. Acquisition of cognitive skill. Psychological Review 1982;89 (4):369-406.

(70) Murray-Slutsky C, Paris BA. Exploring the Spectrum of Autism and Pervasive Developmental Disorders. USA: Therapy Skill Builders, 2000.

(71) Schmidt. Motor Engrams. In Exploring the Spectrum of Autism and Pervasive Developmental Disorders. Therapy Skill Builders, 2000.

(72) Paris BA. Motor Control and Co-ordination Difficulties. In Exploring the Spectrum of Autism and Pervasive Developmental Disorders. Intervention strategies. USA: Therapy Skill Builders, 2000.

(73) Folio RM, Fewell R. Peabody Developmental Motor Scales - Revised. Chicago: Riverside, 2000.

(74) McHale K, Cermak SA. Fine Motor Activities in Elementary School: Preliminary Findings and Provisional Implications for Children with Fine Motor Problems. Amer J of Occup Ther 1992 Oct;46(10): 898 - 903.

(75) Kay MJ. "What is Dysgraphia?" 2008. <http://www.margaretkay.com/Dysgraphia.htm.> [Accessed 10 Oct 2008].

(76) Saunders D. "Pre-writing Skills for Children under Five." 2004. <www.otworks.ca/ otworks_page.asp?pageID=711> [Accessed 27 June 2008].

(77) Feder K, Majnemer A, Synnes A. Handwriting: Current Trends in Occupational Therapy Practice. Canad J of Occup Ther 2000 June;67(3) 197 - 204.

(78) Stamm TA, Cieza A, Machold K, Smolen J, Stucki G. Exploration of the link between conceptual occupational therapy models and the International Classification of Functioning, Disability and Health. Austral Occup Ther J 2006;53(1):9-17.

(79) Hammill D, Pearson N, Voress J. Developmental Test of Visual Perception. 2nd ed. Austin TX: ProEd, 1993.

(80) Fingerhut P, Madill H, Darrah J, Hodge M, Warren S. Classroom-based assessment: validation for the school AMPS. Amer J of Occup Ther 2002;56(2):210-213.

(81) Play therapy International. "Play Therapy - A Definition of Play ." 2007 <http://www.playtherapy.org/playdefinition1.html> [Accessed 17 April 2007].

(82) Rodger S, Ziviani J. OT with children:Understanding Children's Occupations and Enabling Participation. London:Blackwell, 1999.

(83) Parham L, Primeau L. Play and occupational therapy. In L. D. Parham & L. Fazio (Eds.), Play in occupational therapy for children (pp. 2-21). ST.Louis,MO:Mosby, 1997

(84) Molineux M. Occupation for occupational therapists. Oxford, UK: Blackwell Publishing, 2004

(85) Jackson S. Ready for School. London, UK: Ladybird Books Ltd, 2002.

(86) Vogt DS, King DW, King LA. Focus Groups in Psychological Assessment: Enhancing Content Validity by Consulting Members of the Target Population. Psychological Assessment 2004;16(3):231-243.

(87) Reddy V, Kanjee A, Diedericks D, Winnaar L. Mathematics and Science Achievement at South African Schools in TIMSS (Trends in International Mathematics and Science Study). Cape Town: Human Sciences Research Council. 2007.

(88) van den Berg S. Apartheid's Enduring Legacy: Inequalities in Education. J of African Economies 2007;16(5):849-880.

(89) Liddell C. Failing Grade 1: South African Children's First Encounters with School. Psychology and Developing Societies 1996;8(2):223-244.

(90) Parliamentary Monitoring Group. "Matriculation Results 2007 & Fluctuating Pass Rates." 2007. <http://www.pmg.org.za/minutes/20080212-matriculation-results-2007-fluctuating-pass-rates-department-briefing.> [Accessed 7 Oct 2009].

(91) Walker SP, Wachs TD, Gardner JM, Lozoff B, Wasserman GA, Pollitt E, et al. Child development: risk factors for adverse outcomes in developing countries. Lancet 2007;369 (9556):145-57.

(92) Grantham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B, et al. Developmental potential in the first 5 years for children in developing countries. Lancet 2007;369 (9555):60-70.

(93) Milliken L. Scissor Skill. Dana Point, CA USA: Edupress, 1992.

(94) Wolfe RR. Learn to Cut. Arizona, USA: Communication Skill Builders, 1987.

(95) Mahoney S, Markwell A. Developing Basic Scissor Skills UK: Peta, 1999.

(96) Lambert S, Rickerby S. Cutting Activities. Perth, Western Australia: R.I.C Publications, 1999.

(97) Teaching and Learning Company. Shapes to Cut – Animals. Carthage, IL USA: Teaching and Learning Company, 1998.

(98) Shepard J. Self-Care and Adaptations for Independent Living. 4th ed. St Louis, USA: Mosby, 2001.

(99) William MK. "Introduction to Validity." 2006. <http://www.socialresearchmethods.net/kb/constval.php.> [Accessed 6 June 2008].

(100) Kielhofner G. Research in Occupational Therapy. Philadelphia: F.A.Davis Company, 2006.

(101) The Gauteng Department of Education Provincial Schools List <http://www.education.gpg.gov.za/New%20District%20School%20List.xls.> [Accessed 15 November 2008].

(102) The Department of Education Schools List <http://www.education.gov.za/Schoolinfo/Info/schoolinfo.asp.> [Accessed 15 November 2008].

(103) Davies HTO. "What are confidence intervals?" 2001. <www.evidence-based-medicine.co.uk.> [Accessed 2 March 2009].

(104) "Academic Grading in South Africa." 2008 <http://en.wikipedia.org/wiki/Academic grading in South Africa.> [Accessed 7 Oct 2009].

(105) Motala S. Education Resourcing in Post-apartheid South Africa: The impact of Finance Equity Reform in Public Schooling. Perspectives in Education 2006;24 (2):79-93.

(106) Source: South Africa Info. "Education in South Africa." 2008. <http://www.southafrica.info/ess_info/using-sainfo-material.htm.> [Accessed 8 April 2009].

(107) Government Communication and Information System (GCIS). 2008 Yearbook 2007/2008 Education Chapter 7. 2008; Available at: <http://www.gcis.gov.za/docs/publications/yearbook/2008/chapter7.pdf.> [Accessed 5 May 2009].

(108) Dunn M, Loxton H, Naidoo AV. Correlations of scores on the Developmental test of Visual- Motor Integration and Copying Test in a South African multi- ethnic preschool sample. J of Perceptual and Motor Skills 2006;103 (3):951-958.

APPENDIX A

TEST ITEMS

Asymmetrical bilateral tasks - these are done with the dominant hand leading and the non-dominant hand stabilizing.

- 1 Drawing a line with a ruler –

  The item requires the joining of two dots (6 cm apart) with a 30cm, transparent ruler. This item was included in the assessment, as teachers consulted pointed out that children are expected to use a ruler once they start school in Grade 1. Frequently, little time is used to teach this skill in Grade 1, as it is already expected.

- 2 Writing the name –

  Each child is required to write their name on a thin black line of the same thickness as used in school books. The child will be shown a sample in order to provide a visual aid to confirm the task requirement. Generally in schools, children are encouraged to write their names in Grade 0 usually on blank paper and when they enter Grade 1, they are expected to write on lines.

- 3 Threading beads –

  Threading of beads is an activity seen in many Grade 0 classes. This was included as a task that children are exposed to and generally also have the ability to do. The assessment included threading of beads within a time limit, using the dominant hand to thread the beads. Square beads were chosen, similar to those of the Bruininsk-Oseretsky Test of Motor Proficiency. Further, the same time limit of 15 seconds was used, in order to be able to compare results with the standardised test.

- 4 Lacing cards –

  This activity was included as another variation of threading beads. The child was given a plastic card in shape of a crocodile with five holes around the edge. One end of the string was already laced through a hole, in order to prevent incorrect starting positions. The task was to lace the thread through all 5 holes in consecutive order. The child was timed while doing this task.

Asymmetrical differentiated bilateral tasks - these tasks are done with the dominant hand leading and the non-dominant hand performing a different action

- 1 Folding the paper in half –
  Folding is a creative activity done at a Grade 0 level. Each child was given an A4 sheet paper and asked to fold the paper in half. The end-product was shown to the child, so that they understood which way to face the paper i.e. short side along the top edge.
- 2 Cutting out a square and circle –
  Cutting is often commented on in reports for Grade 0 children and is an activity widely used at this level. The cutting task was similar to that used in the Bruininsk-Oseretsky Test of Motor Proficiency where the line to be cut out i.e. the middle circle, is 0,65 mm thick and in bold, surrounded by three outer and three inner circles, increasing and decreasing in size.

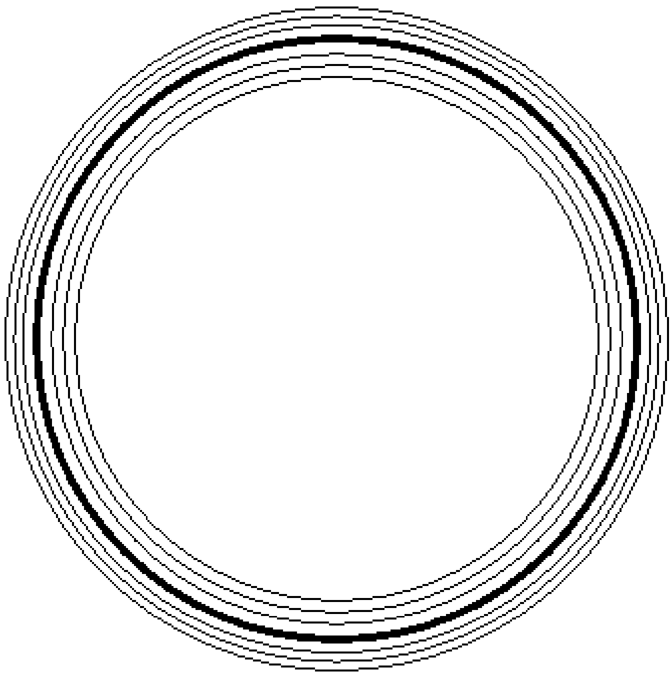


Figure N1 Circle with Outer and Inner Concentric Circles

This item was modified to allow the child to cut around a circle, without the surrounding lines as it could be confusing as to which line should be cut out. The other six concentric circles would be copied onto a transparency and placed over the circle once the child had cut out on the line and purely used for measurement purposes.

The Bruininsk-Oseretsky Test included the circle only and not the square. The square used in this assessment copied the measurements of the circle i.e. same circumference (16cm) and same line thicknesses (0,65 cm).

- 3 Tearing a paper along a line –

  Tearing paper is used in creative activities at a Grade 0 level. For this task, the child was asked to tear along a straight pre-drawn line, using their fingers. The line was 3mm wide and 5cm long. It was situated in the middle of a paper sized 5cm x 6cm.

- 4 Tying shoelaces –

  Children generally learn to tie their shoelaces at a Grade 0 level. Here the child was asked to tie a knot and a bow on a flat plastic shoe, placed in front of the child on the table. 30cm laces were used, to make the tying of the bow easier.

APPENDIX B

DEVELOPMENT OF TEST INSTRUCTIONS

- Drawing a line with a ruler:

The child was shown on a spare test sheet, how to place the ruler underneath the two pre-printed dots and how to join the dots with a single line, starting on the first dot and ending on the second dot. The line had been pre-drawn and the researcher simply copied the action, without actually doing it. The instruction was '**You draw a line**'.

- Writing the name:

The child was shown on a spare test sheet, how a name had been written on the thin black line. The question was asked '**Can you write your name on the line?**' If the child was unable to write his/her name, s/he was then shown a spare test sheet with 3 circles drawn onto the thin black line. Instead of writing his/her name, the child was then asked to copy the 3 circles.

- Threading beads:

As in the Bruininsk-Oseretsky Test, the children were given 5 beads to practice threading. The wording in the Bruininsk-Oseretsky Test was too complex for some of the children in this assessment. Instead of giving the verbal instructions of stringing the beads with the right/left hand and holding the shoelace in the other hand, the researcher placed the shoelace in the correct hand (non-dominant hand). The researcher said '**Put these** (pointing to the beads) **on here**' (pointing to the shoelace in the hand). Once the child had practiced stringing 5 beads onto the shoelace, the beads were removed and placed on the table. The researcher positioned the stopwatch, so that children had that extra awareness of being timed and then said '**Do it as fast as you can**'. The researcher recorded the number of beads placed onto the shoelace in 15 seconds.

- Lacing cards:

The lace had been placed in one end of the holes with the knot at the bottom and the researcher demonstrated how to thread the lace through 3 holes. She then undid the lace so that the child could start at the beginning. The instruction was '**Start now'.**

- Folding the paper in half:

The child was shown how to fold the paper in half by the researcher, who used a spare test sheet, which had been pre-folded correctly. The child was presented with the paper in the correct orientation. The child was told '**Fold the paper**'.

- Cutting out the square and the circle:

The child was presented with the square first and the correct scissors (left or right-handed) were placed on the table in front of the child. While the researcher traced the line with her finger, the child was asked to '**Cut on the line**'. Once the square had been cut out, the child was told to '**Put the scissors on the table**'. The child was then presented with the next test sheet, with the circle drawn on it. The same instructions were given.

- Tearing along a line:

The child was shown an extra test sheet, where the line had been torn half way. The child was asked to '**Tear here'**, the researcher first indicating the correct finger action of tearing and then pointing to the line.

- Tying shoelaces:

The child was presented with the plastic shoe on the table in front of him/her, while saying '**Can you tie this shoe lace?**' If the child did not start tying the shoelace, he was told to '**Try this one**'.

APPENDIX C

IDENTIFICATION OF TASK COMPONENTS

Table C1 Components scored for each item

	Accuracy	Motor	Time	Efficiency
Drawing a line with a ruler	X	X		X
Writing the name	X	X		X
Threading beads		X	X	
Lacing cards		X	X	
Folding the paper in half	X	X		X
Cutting square and circle	X	X	X	X
Tearing a paper along a line	X	X		
Tying shoelaces		X		

The observation sheet previously developed for cutting was used. (5)The 'desired response', described by Levine (6) was expected while the child was cutting. This 'desired response' was summarized and formulated to be answered by yes/no questions. These observations were grouped into scissor grip and cutting motion.

Table C2 Components scored for Scissor Grip

Scissor grip	YES	NO
Thumb through top loop		
Middle finger through bottom loop		
Index finger helps to hold the lower loop		
Loops rest near middle joint of the fingers		
Little and ring finger are in stabilising position		
Scissor grip is constant		
Fingers are in flexed position		
Wrist is in slight (45 degrees) extension		
Forearm is in mid position		
Elbow is flexed at 90 degrees		
Elbow not fixated against trunk		
Scissors are held perpendicular to the floor		
Non-dominant hand holds the paper in midposition		

Table C3 Components scored for Cutting

Cutting motion	**YES**	**NO**
Paper does not tear		
Cutting is rhythmical and smooth		
Snip size remains constant		
Controlled cutting i.e. no mass flexion and extension of fingers		
Child closes scissor properly for at least half the blade i.e. not just snipping		
Wrist moves (slight adjustment) to maintain the scissors on the line		
Assistive hand manipulates the paper		
Elbow remains next to trunk		
No associated movements seen in tongue		

The time taken to cut around the circle and square was also recorded.

APPENDIX D

ALLOCATION OF SCORES FOR THE FINAL TEST ITEMS

Table D1 Scores for each of the Eight Initial Test Items

Item 1 (Joining two dots with a ruler)
Accuracy - this is measured in terms of the distance the child draws along the ruler, without it moving. Total = 6 points
Motor components used – these are measured by the stabilisation of the ruler with the non-dominant hand and its positioning on the ruler. Total = 3 points
Efficiency of movement is measured by the ability to stabilize the ruler without it moving. Total = 2 points
Item 2 (Writing the name)
Accuracy - this is measured by the child's ability to write on the line. Total = 3 points
Motor components used – measured by the child's pencil grip. Total = 4 points
Efficiency - measured by the ability to stabilize the paper. Total = 2 points
Item 3 (Threading beads)
Motor components used - the observation of the child's ability to thread beads by holding the lace with the non-dominant hand and threading with the dominant hand.
Time - the child is given 15 seconds to thread as many beads as s/he can.
Item 4 (Lacing cards)
Motor components used - observation of the child's hand usage.
Time - the child is timed while lacing the card.
Item 5 (Folding the paper in half)
Accuracy - measured by the distance between the folded corners, once the paper has been folded (Distance should be less than 5mm). The child also scores a point if the fold is parallel. Total = 2 points
Motor components used - the observation of how the child folds the paper i.e. how s/he aligns it and how the child presses down the crease. Total = 5 points
Efficiency - measured by the ability to stabilize the paper while the child moves the other hand to the bottom, making the crease. Total = 1 point
Item 7 (Tying shoelaces)
Motor components used – the child is observed while tying shoelaces. S/he scores points for each component successfully completed Total = 8 points

Item 8 (Tearing a paper along a line)
Accuracy – the distance the line is torn correctly is measured, using a line measure. This cm score is then converted into a percentage score. 6cm =100% as the line is 6cm long. If the child did not tear on the line at all, s/he scored 0cm (=0%). Thus the actual length torn correctly times 100% divided by the total length (6cm) resulted in the percentage obtained.
Motor components used – while tearing the paper, the child is observed and points allocated to each component successfully completed. Total = 4 points

CUTTING OUT A SQUARE AND CIRCLE

This item was scored according to:
Accuracy - measured by the ability of the child to cut on the line of the square and the circle.
Here, the standardized Bruininsk-Oseretsky Test was used to work out how many errors the child made while cutting out the circle, i.e. the accuracy of the cutting. In the Bruininsk-Oseretsky Test, the child is presented with a 'heavy circle embedded within six concentric circles'. (page 89) (21) In the Bruininsk-Oseretsky Test the child is asked to cut along the 'heaviest black line'. (page 89) (21) These concentric circles could be confusing for some children, possibly not knowing on which line to cut. Therefore, the child was presented with one circle only, using the same size as the circle to be cut out in the Bruininsk-Oseretsky Test. The concentric circles were then copied onto a transparency, which would be used for scoring only.

The scoring used in the Bruininsk-Oseretsky Test is as follows:
Number of Errors: x

Table D2 BO Score Conversion

Raw Score	Above 10	10	8-9	3-7	0-2
Point Score	0	1	2	3	4

Errors are the ‘number of cuts made through any of the circles that are inside or outside the heavy black line up to a maximum of 11.’ (pg. 89) (21)

The researcher also included the method of scoring accuracy according to the Master’s Dissertation, where a line measure was used to determine the accuracy. A line measure is a tool used to measure the length of a curved line. The length that the child cut off the pre-drawn line was measured. The wheel of the line measure was placed on the black line from where the child stopped cutting on the black line, and then moved along up to where he cut on the line again (i.e. the distance where the child did not cut on the black line was measured). As the line measure was moved along, the wheel turned, giving an accuracy score in centimetres (cm). If the child cut on the line all of the time, the line measure score was 0 cm, as no part was off the pre-drawn line and no distance was measured. (5)
To convert the accuracy score in cm to an accuracy percentage score the following methodology was used:
The total length of the circle (16cm) minus the line measurement (x cm) equals the accuracy score (in cm). The percentage is then calculated by dividing the accuracy score (in cm) by the total score (16 cm) and multiplying the result by 100.
A percentage score of x, 5 was rounded down and a percentage score of x,51 was rounded up.

The same scoring was used for the circle and also the square. Although the Bruininsk-Oseretsky Test only included a circle, both methods of scoring were used for the square as well. The square was the same length as the circle, i.e. 16 cm. Outer and inner squares were then constructed, using the same distances as in the circle. Thus each child was scored a point score and a percentage score for the square.

Motor components used –
‘An observation sheet or qualitative questionnaire was filled out while the child was cutting. Questions were in Yes/No format and included topics of scissor grip and

cutting motion. There were 22 questions in total. The researcher used two different coloured pens (blue and red), in order to answer the questions. Initially the child was observed cutting the square and the questions were answered as Yes or No. This was done using the blue pen. Once the child was cutting the circle, it was noted that the child's quality of cutting changed or sometimes declined and therefore some answers that had previously been answered by a Yes, now were answered by a No.

As soon as there was a decrease in performance in cutting, the red pen was used on the observation sheet. (5)

Time – the child was timed while cutting out the shapes, although no emphasis was placed on speed. This was done from when the child started cutting on the paper, until the shape was cut out. It was done separately for the square and the circle.

WEIGHTING OF SCORES

All of the 8 items had a total score that was different and thus not comparable. Thus the scoring was weighted, according to the importance of the items. This was done by the panel of Occupational Therapists. Each test item was allocated a 'weighted number', with the most important item i.e. cutting having the highest score (18.39) and the least important one (drawing a line with a ruler) the lowest score (5.39). All scores added together yielded 100 points. The weighted scores could be used to work out a composite score of the overall assessment.

The composite score was worked out by multiplying each test score with its weighted number.

All of these scores were then added together, giving a total score. This total score was then divided by the maximum score, which were the maximum points available. (Composite score = Total score/ maximum points).

APPENDIX E

WEIGHTING OF TEST ITEMS INCLUDING BUTTONING A SHIRT:

- Cutting (18,39)
- Tearing (14,12)
- Tying Shoelaces (11,58)
- Folding (11,28)
- Drawing around an object (11,04)
- Name writing (10,74)
- Threading beads (9,48)
- Lacing (7,98)
- Drawing with a ruler (5,39)

APPENDIX F

PILOT CONSENT FORM AND QUESTIONNAIRE

Dear Parent(s)

I am an Occupational Therapist in the process of conducting my Doctorate on the development of skills in young children. Your child's school has been chosen through stratified sampling to take part in my research project. I shall be most grateful if you would allow your child to participate in this research.

The objective of my study is to evaluate some fine motor skills in normal Grade 0 children to provide information on what normal children do.
In order for me to gain an understanding of your child's fine motor development, I would like to ask you to please fill out a one-page questionnaire before the research commences.

The research involves taking your child out of the classroom situation for about 10 minutes to complete various fine motor tasks such as threading or folding. This will be done twice in the following week. There are no costs or risks involved. Results are confidential and no names will be used in the documentation. The school will not receive individual reports on children.

Participation in the research project is voluntary. Please confirm your consent for this research as detailed below.

Yours sincerely

Ingrid Ratcliffe

I, the undersigned allow ________________________________ (Child's name)
to take part in this research project.

(Signature) (Date)

PARENT QUESTIONNAIRE

Child's name: ____

Date of Birth: ____

Thank you for taking the time to fill out this questionnaire. The following questions help me, to gain an understanding of your child's fine motor development. Please answer the questions as honestly as possible. No names will be used in any documentation and information will be treated confidentially.

1. Did your child attend a nursery school before going to Grade 0? Yes / No

Name ____

Period ____

2. Where does your child generally go when school closes at 1pm (please tick)

   Home ________ Aftercare __________ Other _______________

3. Do you (mother) work

   Full-time ______ Part-time ___________ Other _______________

4. Do you (father) work

   Full-time ______ Part-time ___________ Other _______________

5. What activities do you (mother and/or father) do with your child?

   Extra murals ____

   ____

   At home ____

   ____

6. How much time do you spend with your child on average per day?

   ____

7. Do you have :

colouring pencils	Yes / no
Paintbrush and paint	Yes / no
Paper	Yes / no
Beads	Yes / no
Scissors	Yes / no
Kokis	Yes / no
Playdough	Yes / no

Is your child allowed to use these on his/her own? Yes / no

Thank you for your time!!

Kind Regards,
Ingrid Ratcliffe

APPENDIX G

VALIDITY TESTING ASSESSMENT SCORING SHEET:

Table F1 Bilateral Item Scoring Sheet

DRAWING WITH A RULER	
Stabilising hand (R / L)	R / L
Ruler stabilized between the two dots	3
Ruler stabilized immediately next to the dot (index within 2 cm)	2
Ruler stabilized far away from the dots	0
Ruler	
Ruler does not move at all	1
Ruler moves	0
Line Drawing	R / L
Child draws on the ruler for 6 cm and the two dots are joined	6
Child draws on the ruler for 5 cm and the ruler is touching one dot	5
Child draws on the ruler for 4 cm and the ruler is touching one dot	4
Child draws on the ruler for 3 cm and the ruler is touching one dot	3
Child draws on the ruler for 2 cm and the ruler is touching one dot	2
Child draws on the ruler for 1 cm and the ruler is touching one dot	1
Child draws free hand	0
NAME WRITING	
Stabilising Hand	R / L
Child stabilizes the paper with the non-dominant hand	2
Child stabilizes the paper for some of the time	1
Child does not hold the paper with the non-dominant hand	0
Writing	R / L
Child writes the whole name on the line (looking at the first 3 letters)	2
At least one letter (looking at the first 3 letters) is touching the line	1
No letters are on the line	0
Pencil grip	
Tripod grip	1
Three fingers on the shaft	0
Lateral grip or other	0

FOLDING PAPER	
One hand stabilizes the paper at the top while the other hand makes the crease	1
Once the paper is aligned at the top, the child runs the dominant hand down to the bottom, to start off the crease	1
Child presses down the crease with the thumb	1
The fold is parallel	1
The distance between the folded corners is less than 5 mm	1
THREADING BEADS	
Timing	
Which hand does the threading	R / L
Is this hand constant	Yes / No
Which hand pulls the thread through	R / L
Is this hand constant	Yes / No
TEARING	
Both thumbs are placed on the line	1
One thumb moves towards and the other away from the child	1
Both thumbs move simultaneously	1
The child starts tearing from the top, towards the bottom	1
LACING	
Timing	
Which hand holds the card	R / L
Which hand does the lacing	R / L
Is there a change in function of the hand	Yes / No
TYING SHOELACES	
Tying a knot	1
Pulling the free ends in the right direction	1
Making the loop of one bow	1
Holding the loop at the knot and not higher up	1
Putting the other lace around the bow	1
Pushing it through the hole	1
Making a second bow	1
Making a knot with the two bows	1
Pulling both bows tight	1
Pulling the bows in the right direction	1

Table F2 Cutting Item Scoring Sheet

OBSERVATION SHEET

Date of assessment	
Birth date	
Current age	
Sex	
School	
Dominance	

Scissor grip	**YES**	**NO**
Thumb through top loop		
Middle finger through bottom loop		
Index finger helps to hold the lower loop		
Loops rest near middle joint of the fingers		
Little and ring finger are in stabilising position		
Scissor grip is constant		
Fingers are in flexed position		
Wrist is in slight (45 degrees) extension		
Forearm is in mid position		
Elbow is flexed at 90 degrees		
Elbow not fixated against trunk		
Scissors are held perpendicular to the floor		
Non-dominant hand holds the paper in midposition		

Cutting motion	**YES**	**NO**
Paper does not tear		
Cutting is rhythmical and smooth		
Snip size remains constant		
Controlled cutting i.e. no mass flexion and extension of fingers		
Child closes scissor properly i.e. not just snipping		
Wrist moves (slight adjustment) to maintain the scissors on the line		
Assistive hand manipulates the paper		
Elbow remains next to trunk		
No associated movements seen in tongue		

Time Taken
Picture one (square)
Picture two (circle)
Comments

APPENDIX H

BRUININSK-OSERETSKY SCORES VERSUS PERCENTAGE SCORES

Table H1 Comparison of point scores and accuracy scores in %

Participants	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b
BO Score	2	3	4	4	3	3	3	4	0	0	2	0	3	0	2	4
Initial %	0	16	19	25	0	0	0	41	0	19	0	6	9	0	3	31
Adapted %	28	87	100	100	81	64	64	100	37	62	12	9	84	66	75	94

This table shows the Bruininsk-Oseretsky score and the initial percentage score obtained. Further, it shows the adapted percentage score, which was a little more lenient. The results show, that the adapted percentage scores correlate better with the Bruininsk-Oseretsky scores.

THREADING BEADS SCORES

Table H2 Comparison of Threading Beads with Bruininsk-Oseretsky Scores

Participants	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b
Threading Beads	5	5	5	5	4	5	5	5	3	4	6	7	5	5	6	5
BO Point Score	2	2	2	2	1	2	2	2	1	1	3	4	2	2	3	2

The raw score was converted to a point score, which was obtained as the number of units completed within a fixed time period. This was done with an attempt to use a range of point scores sufficient to discriminate between different levels of performance. (21)

APPENDIX I

ADAPTED VALIDITY TESTING ASSESSMENT FORM

Table I1 Bilateral Item Scoring Sheet

DRAWING WITH A RULER			
Stabilising hand (R / L)	R / L	R / L	R / L
Ruler stabilized between the two dots	3	3	3
Ruler stabilized at the dot	2	2	2
Ruler stabilized next to the dot (index within 2 cm)	1	1	1
Ruler stabilized far away from the dots, at edge of the paper	0	0	0
Ruler			
Ruler does not move at all	2	2	2
Ruler moves	1	1	1
Ruler held but not used	0	0	0
Line Drawing (once the ruler moves, stop measuring)	R / L	R / L	R / L
Child draws on the ruler for 6 cm and the two dots are joined	6	6	6
Child draws on the ruler for 5 cm and ruler touches one dot	5	5	5
Child draws on the ruler for 4 cm and ruler touches one dot	4	4	4
Child draws on the ruler for 3 cm and ruler touches one dot	3	3	3
Child draws on the ruler for 2 cm and ruler touches one dot	2	2	2
Child draws on the ruler for 1 cm and ruler touches one dot	1	1	1
Child draws free hand	0	0	0
NAME WRITING			
Stabilising Hand	R / L	R / L	R / L
Child stabilizes the paper with the non-dominant hand	2	2	2
Child stabilizes the paper for some of the time	1	1	1
Child does not hold the paper with the non-dominant hand	0	0	0
Writing	R / L	R / L	R / L
Child writes whole name on line (looking at first 3 letters)	3	3	3
2 letters are touching the line (looking at first 3 letters)	2	2	2
1 letter is touching the line (looking at the first 3 letters)	1	1	1
No letters are on the line	0	0	0
Pencil grip			

Dynamic tripod grip	1	1	1
Three fingers on the shaft	0	0	0
Lateral grip or other	0	0	0
Pencil held 2 – 3 cm from the tip	1	1	1
Pencil held too close or too far up the shaft	0	0	0
Shaft resting in the web-space	1	1	1
Vertical pencil shaft	0	0	0
FOLDING PAPER			
Child aligns the paper at the top with both hands	1	1	1
Child aligns one corner	0	0	0
Once aligned, the child runs one hand down the middle	2	2	2
Child holds top of paper and presses crease with base of both hands together	1	1	1
One hand holds top at the side while other hand makes the crease	1	1	1
Child presses down the crease with the thumb or fingers	1	1	1
Child presses crease with base of hand	0	0	0
Child presses crease from the middle out	1	1	1
Child presses crease from L to R or vice versa	0	0	0
The fold is parallel	1	1	1
The distance between the folded corners is less than 5 mm	1	1	1
TEARING			
Both thumbs are placed on the line	1	1	1
One thumb moves towards and the other away from child	1	1	1
Both thumbs move simultaneously	1	1	1
The child starts tearing from the top, towards the bottom	1	1	1
Accuracy in %			
THREADING BEADS			
How many beads are threaded in 15 seconds			
Does the child change the hand and need a second trial	Yes/No	Yes/No	Yes/No
TYING SHOELACES			
Tying a knot	1	1	1
Pulling the free ends in the right direction	1	1	1
Making the loop of one bow	1	1	1
Holding the loop at the knot and not higher up	1	1	1
Putting other lace around the bow / making a second bow	1	1	1
Pushing it through the hole / making knot with two bows	1	1	1

Pulling both bows tight	1	1	1
Pulling the bows in the right direction	1	1	1
DRAWING AROUND AN OBJECT			
The child starts drawing at 10h00	3	3	3
The child starts drawing at 12h00	2	2	2
The child starts drawing at 3h00	1	1	1
The child starts drawing at 6h00	0	0	0
A R-handed child draws clockwise (+vice versa)	1	1	1
The child stabilizes the hand on the object at all times	1	1	1
The stabilizing hand lifts up	0	0	0
The child draws with the dominant hand only	1	1	1
The child changes the drawing hand	0	0	0
The child maintains the line on the object	1	1	1
BUTTONING			
The child places his thumb on the button hole	1	1	1
The L hand pushes the button through the button hole	1	1	1
The R hand pulls the button through	1	1	1
The L hand pulls the material, so the button slides through	1	1	1
Timing for 3 buttons			

APPENDIX J

SCORING FOR 'FOLDING PAPER'

Initially the child could score points for stabilising the paper, pressing down the crease and for accuracy of the fold. Observing children folding paper, it became evident that more methods were used.

When aligning the paper at the top

- they either aligned the top edge;
- they used one corner and then the next;
- they simply used one corner only.

Pressing down the crease also varied;

- children generally did not stabilise the paper at the top, while making the crease with the other hand;
- they made the crease with the base of the hands;
- they stabilised the paper on the side, rather than the middle;
- children did not necessarily press the crease down with the thumb;
- they often used the hand to press down the crease;
- the paper was either creased from side to side, or from the middle out.

Table J1 Folding Paper

FOLDING PAPER	
Child aligns the paper at the top with both hands	1
Child aligns one corner, then the next corner	1
Child aligns one corner only	0
Once aligned, the child runs one hand down the middle	2
Child holds top of paper and presses crease with base of both hands together	1
One hand holds top at the side while other hand makes the crease	0
Child presses down the crease with the thumb or fingers	1
Child presses crease with base of hand	0

Child presses crease from the middle out	1
Child presses crease from L to R or vice versa	0
The fold is parallel	1
The distance between the folded corners is less than 5 mm	1
The fold is pressed down properly so the paper does not lift	1

APPENDIX K

SCORING FOR 'DRAWING AROUND AN OBJECT'

Test instructions for this item were '**Draw around this bowl**'.

Table K1 Drawing around an Object

DRAWING AROUND AN OBJECT	
The child starts drawing at 10h00	3
The child starts drawing at 12h00	2
The child starts drawing at 3h00	1
The child starts drawing at 6h00	0
A R-handed child draws clockwise (+vice versa)	1
The child stabilizes the hand on the object at all times	1
The stabilizing hand lifts up	0
The child draws with the dominant hand only	1
The child changes the drawing hand	0
The child maintains the line against the object	1

This scoring sheet is for a R-handed child. The L-handed child uses mirror starting points on the clock i.e. if the child starts drawing at 2h00, s/he scores 3 points. At 12h00 s/he scores 2 points, at 9h00 s/he scores 1 point and at 6h00 s/he scores 0 points.

APPENDIX L

SCORING FOR 'BUTTONING'

Test instructions for this item are: '**Close the buttons as fast as you can**'.

Table L1 Buttoning

BUTTONING A SHIRT	
The child places his thumb on the button hole	1
The L hand pushes the button through the button hole	1
The R hand pulls the button through	1
The L hand pulls the material, so the button slides through	1
Timing for 3 buttons	

APPENDIX M

SCORING FOR BILATERAL SKILLS

Cutting a square and circle

It was felt that it was difficult to fill in the observation sheet while observing the children cutting out the two shapes, as there were many points to observe. This was not a problem during the Master's study, as the children cut out 7 shapes and thus took a longer time period. (5) It was felt that a video would be useful, as one would be able to review this a few times while filling out the observation sheets.

After pilot study 1, 4 children were filmed in order to test this new method of observing data. Various placements of the video were tried and recorded. The observation sheet was revised, looking at the viability of observing all of the motor components on video.

The initial observation sheet had 'Little and ring finger are in stabilising position' as well as 'Fingers are in flexed position'. It was felt that the observation of little and ring fingers in the stabilising position was adequate to record. Further, if fingers were held in extension, rather than flexion, this would also be noted under 'controlled cutting', i.e. no mass flexion and extension of fingers.

Initially the researcher observed if the wrist was in slight (45 degrees) extension. In the cutting process, however, the wrist is dynamic and moves from extension through midposition into flexion. If the wrist were held in flexion constantly, this would be observed also by abduction of the arm or fixation of the forearm.

In the initial observation sheet, the researcher observed if 'cutting is rhythmical and smooth'. This still fluctuated with children and it was felt that this was observed when looking at 'Controlled cutting'. Further, it was also noted if edges were smooth or jagged, indicating if cutting was smooth.

The observation of 'snip size remaining constant' was also excluded. The researcher decided that the observation of closing the scissors versus snipping was more

appropriate. Often the snip size was adjusted according to the shape cut out, thus fluctuating, however, this actually being a desired response.
The observation ‘wrist moves to maintain scissors on the line’ was excluded, as this was difficult to observe on the video.

Table M1 Cutting Item Scoring Sheet

Scissor grip	YES	NO
Thumb through top loop		
Middle finger through bottom loop		
Index finger helps to hold the lower loop		
Loops rest near middle joint of the fingers		
Little and ring finger are in stabilising position		
Scissor grip is constant		
Forearm is in mid position		
Elbow is flexed at 90 degrees		
Elbow not fixated against trunk		
Scissors are held perpendicular to the floor		
Non-dominant hand holds the paper in midposition		

Cutting motion	YES	NO
Paper does not tear		
Controlled cutting i.e. no mass flexion and extension of fingers		
Child closes scissor properly for at least half the blade i.e. not just snipping		
Assistive hand manipulates the paper		
Elbow remains next to trunk		
No associated movements seen in tongue		
Child closes scissors in corner of square		
Child uses bilateral approach when cutting circle		

Drawing with a ruler

The children were asked to join two dots, using a ruler to draw the line. Generally children touched at least one of the dots. At times the child drew a line parallel to the expected line, but slightly below i.e. not touching any of the dots. The researcher felt that if the line were within 1mm from the dot, scoring would be the same as when touching the dot i.e. a margin of error was allowed.

If the child stabilised the ruler but did not touch the dots and the line was parallel then s/he would score a maximum of 3 points. Here the distance would be halved i.e. for 6cm on the line the child would score 3 only, as s/he was penalized for not touching the dots.

If the child stabilised the ruler and touched one dot, yet the line did not go to the other dot but rather diagonally up or down at an angle, the child would score a maximum of 2 points i.e. for a line drawn 6cm on the ruler the child would score 2 only (i.e. 6 divided by 3).

The result in cm would be rounded up, if the child scored x,51 and down if the child scored x,5.

<u>Name writing</u>

The dynamic tripod pencil grip scores 2 points. The tripod pencil grip scores 1 point only, if the child places the thumb on the index finger, or if the index finger extends further on the shaft of the pencil than the thumb.

Table M2 Pencil Grip

	NAME WRITING	
	Pencil grip	
M	Dynamic tripod grip	2
M	Tripod grip with thumb on index finger, or index further front	1
M	Three fingers on the shaft	0
M	Lateral grip or other	0

The child scores points for the ability to write the first three letters on the line. Here the child is expected to write the letters within 1mm above the line, but s/he may not extend under the line.

Table M3 Name Writing

	NAME WRITING	R / L
A	Child writes whole name on line (looking at first 3 letters)	3
A	2 letters are touching the line (looking at first 3 letters)	2
A	1 letter is touching the line (looking at the first 3 letters)	1
A	No letters are on the line	0
A	All letters are above the line	1
A	Some letters are below the line	0

Tearing

During the assessment, the researcher observed the child's responses and marked these on the scoring sheet. While observing how children did tearing on a line, it was felt that they should stop more than once, for it to qualify as 'tearing in stages'. Thus the child scored a 'yes' for 'tearing in stages', if s/he stopped at least twice on the line, readjusting the fingers to continue the tearing process.

Table M4 Tearing

	TEARING ON A LINE	
M	Both thumbs are placed on the line	1
M	One thumb moves towards and the other away from child	1
M	Both thumbs move simultaneously	1
M	The child starts tearing from the top, towards the bottom	1
M	Tearing is done in stages	Yes/No
A	Accuracy in %	

Drawing around an object

More variation was given with allowance for a margin of error:

Table M5 Drawing around an Object

	DRAWING AROUND AN OBJECT	
A	The child maintains the line on the object	3
A	The line deviates from the object once	2
A	The line deviates from the object twice	1
A	The line deviates many times	0
A	Circle closed completely	2
A	Circle closed but line extends for more than 1cm at join	1
A	The circle is open	0

<u>Buttoning a shirt</u>

The positioning of the forearm is taken into consideration:

Table M6 Buttoning

	BUTTONING A SHIRT				
M	Child places the thumb on the button hole for all 3 buttons				2
M	Child places thumb on hole for 2 buttons				1
M	Child places thumb on button hole for 1 or 0 buttons				0
M	The R hand pushes the button through the button hole				1
M	The L hand pulls the button through				1
M	The R hand pulls the material, so the button slides through				1
T	Timing for 3 buttons				

APPENDIX N

DIRECTIONS ON HOW TO VIDEO CHILDREN WHILE CUTTING

This was done in the following way:

Starting on the dominant side, the researcher sat 1m at 90 degrees to the child. The researcher videoed the child from the time when s/he picked up the scissors and paper, until s/he had completed cutting the shape. The researcher did not zoom in on the task but rather filmed the side of the child, looking at the positioning of the forearms, involvement of both hands in the task as well as associated reactions. For the second shape, the researcher moved to the non-dominant side. Here, she videoed slightly from the back i.e. over the child's shoulder. She zoomed in on the hands, especially the position of the scissor in the hand as well as the manipulation of the non-dominant hand.

The researcher timed the child while videoing the cutting.

APPENDIX O

SCORING FOR NEW OBSERVATIONS FOR CUTTING

Various observations were added to the cutting observation sheet:

- Did the child close the scissors in the corner when cutting the square? If the square was cut out correctly, the child was able to close the scissors in 3 corners, thus scoring 3 points. If the child closed the scissors in 2 corners, s/he scored 2 points. S/he scored 1 point if closing the scissors in one corner and 0 points if the scissors were not closed, but rather stopped at any point of the blade.
- Did the child use a bilateral approach when cutting the circle. This observation was scored with 1 point if the child used a bilateral approach and 0 if s/he did not yet use a bilateral approach.
- Which direction did the child cut (clockwise or anti-clockwise)? The direction was noted. A R-handed child scores 1 point for cutting anti-clockwise and a L-handed child scored 1 point for cutting clockwise.
- Was the cutting edge smooth? The child scored 1 point if the cutting edge was smooth and 0 points if the cutting edge was jagged.
- Did the child cut out the shape only or did it approach the shape? Here the child scored 2 points if he cut out the shape and was thus left with the shape only and the rest of the paper. He scored 1 point if he was left with 3 pieces (i.e. the shape and 2 pieces). He scored 0 points if he was left with more than 3 pieces of paper.
- The accuracy and BO scores were recorded on the observation sheet.

Table O1 Cutting Item Scoring Sheet

	Assessment 1	Assessment 2	Assessment 3
Time (square) +direction			
Time (circle) + direction			
Smooth outline (square)			
Smooth outline (circle)			
Shape cut (square)			
Shape cut (circle)			
Square BO			
Square %			
Circle BO			
Circle %			

APPENDIX P

SCORING CRITERIA FOR PENCIL GRIP

Initially, the child could score 2 points for the dynamic tripod grip, 1 point for the tripod grip but with slightly incorrect positioning of the index finger or thumb and 0 points for three fingers on the shaft or a lateral grip. (Appendix M) While observing the children, it became clear that a distinction between three fingers on the shaft and a lateral grip should be made. The lateral grip thus received 0 points and three fingers on the shaft 1 point. The static tripod grip received 2 points and the dynamic tripod grip 3 points.

Table P1 Pencil Grip

	Pencil grip	**R**	**L**	**R**	**L**	**R**	**L**	
M	Dynamic tripod grip							3
M	Tripod grip with thumb on index finger, or index further front							2
M	Three fingers on the shaft							1
M	Lateral grip or other							0

APPENDIX Q

FINAL ASSESSMENT SCORING SHEET

Table Q1 Final Bilateral Item Scoring Sheet

	NAME WRITING							
	Stabilising Hand	R	L	R	L	R	L	
E	With the non-dominant hand							2
E	For some of the time							1
E	Child does not hold the paper with the non-dominant hand							0
	Pencil grip	R	L	R	L	R	L	
M	Dynamic tripod grip							3
M	Tripod grip with thumb on index finger, or index further front							2
M	Three fingers on the shaft							1
M	Lateral grip or other							0
M	Pencil held 2 – 3 cm from the tip							1
M	Pencil held too close or too far up the shaft							0
M	Shaft resting in the web-space							1
M	Vertical pencil shaft							0
	Writing	R	L	R	L	R	L	
A	Child writes whole name on line							3
A	2 letters are touching the line							2
A	1 letter is touching the line							1
A	No letters are on the line							0
A	All letters are above the line							1
A	Some letters extend below the line							0
	DRAWING AROUND AN OBJECT							
M	The child starts drawing at 10h00							3
M	The child starts drawing at 12h00							2

M	The child starts drawing at 3h00				1
M	The child starts drawing at 6h00				0
M	A R-handed child draws clockwise (+vice versa), all the time				1
M	Child changes direction or draws incorrect way				0
E	The child stabilizes the hand on the object at all times				1
E	The stabilizing hand lifts up				0
M	The child draws with the dominant hand only				1
M	The child changes the drawing hand				0
E	Child does activity in sitting				1
E	Child stands up to draw				0
A	The child maintains the line on the object				3
A	The line deviates from the object once				2
A	The line deviates from the object twice				1
A	The line deviates from the object many times				0
A	One join				2
A	Two joins				1
A	Three or more joins				0
A	Circle closed completely				2
A	Circle closed but line extends for more than 1cm				1
A	Circle is open				0
	TEARING				
M	Both thumbs are placed on the line				1
M	One thumb moves towards and the other away from child				1
M	Both thumbs move simultaneously				1
M	The child starts tearing from the top, towards the bottom				1
M	Tearing is done in stages				1
M	Child has no accidental tear				2
M	Child has one accidental tear				1
M	Child has more than one accidental tear				0

A	Accuracy in %				
	THREADING BEADS				
T	How many beads are threaded in 15 seconds				
M	Does the child change the hand and need a second trial				
	TYING SHOELACES				
M	Tying a knot				1
M	Pulling the free ends in the right direction				1
M	Making the loop of one bow				1
M	Holding the loop at the knot and not higher up				1
M	Putting other lace around the bow / making a second bow				1
M	Pushing it through the hole / making knot with two bows				1
M	Pulling both bows tight				1
M	Pulling the bows in the right direction				1
	BUTTONING				
M	Child places the thumb on the button hole for all 3 buttons				2
M	Child places thumb on hole for 2 buttons				1
M	Child places thumb on button hole for 1 or 0 buttons				0
M	The R hand pushes the button through the button hole				1
M	The L hand pulls the button through				1
M	The R hand pulls the material, so the button slides through				1
T	Timing for 3 buttons				

Table Q2 Final Cutting Item Scoring Sheet

OBSERVATION SHEET (CUTTING)

Date of assessment	
Birth date	
Current age	
Sex	
School	
Dominance	

Scissor grip	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**
Thumb through top loop						
Middle finger through bottom loop						
Index finger helps to hold the lower loop						
Loops rest near middle joint of the fingers						
Little and ring finger are in stabilising position						
Scissor grip is constant						
Forearm is in mid position						
Elbow is flexed at 90 degrees						
Elbow not fixated against trunk						
Scissors are held perpendicular to the floor						
Non-dominant hand holds the paper in midposition						

Cutting motion	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**
Paper does not tear						
Controlled cutting i.e. no mass flexion and extension of fingers						
Child closes scissor properly for at least half the blade i.e. not just snipping						
Assistive hand manipulates the paper						
Elbow remains next to trunk						
No associated movements seen in tongue						
Child closes scissors in corner of square						
Child uses bilateral approach when cutting circle						

	Assessment 1	Assessment 2	Assessment 3
Time (square) +direction			
Time (circle) + direction			
Smooth outline (square)			
Smooth outline (circle)			
Shape cut (square)			
Shape cut (circle)			
Square BO			
Square %			
Circle BO			
Circle %			

APPENDIX R

DETAIL OF SCISSOR SKILL PROGRAMS

Scissor Skill (94)

This book contains a teacher's guide. One of the objectives is to practice and master a cutting skill. Teachers are asked to show students the correct way of holding scissors.

The book then contains a 'Skills Checklist'. This is a one-page table, allowing the teacher to fill in each pupils name and being able to mark off the date when a child achieved a certain skill. This checklist is used as a tool for recording fine motor development and enables the teacher to refer to individual progress.

Skills listed on the checklist are the actual practice pages. These 7 pages are to be reproduced for skill practice before beginning a project. Children are encouraged to colour in the practice pages to develop colouring skills.

Practice pages include:

1: 5 solid straight lines (3mm) and 5 dotted straight lines (2mm)
These lines do not touch the edge of the page but leave a gap of 1 cm.

2: Large & small circles (2mm)

3: Scallops (1,5 mm). There are 6 rows of scallops.

4: Fringing. (1,5 mm).

5: Large and small spirals. (1 - 2 mm). They seem to be hand-drawn and are thus uneven. All three spirals are drawn for right-handed persons i.e. the spiral is held with the left hand while the right hand cuts anti-clockwise.

6: Curves. (1mm).

7: Zigzag Lines and Angles. (1 - 2mm).

The order on the Scissor Skill Checklist does not correspond to the order of the practice pages. The skill checklist is ordered in the following way, presuming increased order of difficulty: solid straight line, dotted straight line, fringing, zigzag, angles, circles (large), circles (small), spirals (large), spirals (small), curves and finally scallops.

The book then has Project pages, each with a picture to be cut out. The Skill is listed i.e. which part of the practice pages is applied in the activity. For example a picture of a football to be cut out requires the skill of large curves. Secondly, sequential steps for completing the picture project are listed. Lastly, Suggestions are added for the project's visual appeal. These suggestions also develop other fine motor skills such as pasting, finger painting, handling a paintbrush, rolling and curling.

The book then has 60 Project pages, each with a picture to be cut out. These are divided into the seasons, with 4 – 5 pictures/projects per month. Pictures include:
Autumn – football, crayon, picture frame, leaf, cheese, mask, lantern, cat, ocean waves, ghost, witch, pilgrim hat, corn, turkey, cornucopia, pie.
Winter – Santa, stocking, Christmas tree, candle, present, reindeer, gingerbread, penguin, dragon, polar bear, snowflake, lovebirds, broken heart, paw print, stars and stripes, cupcake, peppermint.
Spring - woolly lamb, leprechaun, lion, shamrock, pig, chick, bunny, cracked egg, carrot, rain cloud, basket, spider, web, green grass, vase, tulip.
Summer – sun, balloon, pizza, blue ribbon, pretzel, root beer, turtle, sailboat, lollipop, cactus, gummballs

Learn to Cut(95)

Part 1: 8 skills are structured in a hierarchy of steps –

1: snipping lines of varying lengths (6mm thick)

2: cutting a line (3mm)

3: cutting a simple shape (strips, squares, rectangles, triangles and diamonds) with a 6mm line

4:	cutting a simple shape with a 3mm line
5:	cutting two simple shapes with a 3mm line
6:	cutting a complex shape (circle, oval, crescent, heart and star) with a 4 - 6mm line
7:	cutting a complex shape with a 2mm line
8:	Cutting two complex shapes with a 2mm line

Pre- and Posttests measure achievement for each skill. Children begin the program on the skill level indicated by the first pretest error.
Each pretest item is paralleled by a structured worksheet.
A recording sheet is included for tracking each child's tests and daily progress.
In part 1 the child cuts out shapes only.

Part 2: This contains 61 individual art projects.
All of these pictures have dotted lines for cutting (width 2mm and some 1mm)
The pictures focus mainly on the shapes practiced, rather than combined patterns (e.g. no animals). Shapes are cut out and pasted to complete the picture.
Pictures are not ordered in terms of level of difficulty.

Developing Basic Scissor Skills (96)

14 steps in scissor skill development:
Child enjoys tearing paper
Child shows an interest in and understands the use of scissors
Child is able to maintain the correct grip when positioned by an adult
Child is able to hold scissors appropriately without assistance
Child begins to open and close scissors
Child is able to open and close scissors using a controlled action
Child is able to hold paper and make random cuts
Child is able to make consecutive cuts with forward movement
Child is able to cut straight lines avoiding unintentional lateral movement

Child is able to cut out simple shapes involving one change of direction
Child is able to cut out simple shapes, more than one directional change
Child is able to cut along curved lines
Child is able to cut out circles
Child is able to cut more complicated shapes with straight and curved lines

No specific ages are given for these. Generally the program seems to have been developed for Key Stage 1.

Grading:

a Pre-scissor skills: tearing and scrunching paper; using a punch; squeezing empty plastic bottles; finger puppets; hand and finger rhymes; modeling clay or dough; musical instruments.
b How to hold scissors i.e. middle finger and thumb in loops. The index finger is placed on the underside of the scissor for support. Peta scissors have wide loops to provide large finger contact area, giving the child increase control of the cutting action.
c Cutting in a controlled action e.g. cutting straws
d Cutting straight lines (18mm then 3mm)
e Cutting straight line with one corner (45 degree angle) (18mm then 3mm)
f Cutting zig-zag line (16mm then 3mm)
g Cutting straight lines (0,5mm)
h Cutting square, rectangles and trapeze (0,5mm)
I Cutting triangles (0,5mm)
j Cutting a curve (12mm then 3mm)
k Cutting a circle (19mm then 1mm)
l Cutting circles, ovals and rectangles (0,5mm)
m Cutting a complex shape (butterfly; 1mm) This is the only drawing where the lines touch the edge.

Cutting Activities (97)

This program consists of 40 pictures. All lines to be cut on are dotted lines. Mostly the child does not cut out the actual picture, but rather a square around the picture. This the child then cuts into parts, which are used as a jigsaw puzzle. Initially the child cuts straight lines. By the third picture, gentle curves are introduced already. Then the child cuts triangles, followed by squares. Circles are then introduced, followed again by straight lines. More pictures then require the child to cut out circles, followed by a moon shape as well as a semi-circle. Next, the child has to cut a spiral. Lastly, integrated shapes are drawn, such as a tree. The program ends on straight lines.

Shapes to Cut – Animals (98)

This booklet includes 28 pictures of animals. General line thickness is 1 – 1,5 mm. The child cuts out the general outline of the animal. As soon as there is a slight increase in difficulty of the shape, the line thickness is increased (up to 2cm), to prevent cutting of too many curves or too many changes in direction.

APPENDIX S

TEACHER INSTRUCTION SHEET

Teacher information sheet (This will be discussed and shown to teachers, rather than just used as a hand-out)

Thank you for using this program in your classroom. The aim of this program is to improve cutting skills in Grade 0 children.

Please could you do this program in the first part of your morning, before 1st break?

The program consists of two sections. One is the practice section and the other a picture section. The child cuts the A4 paper in half, on the black line, dividing the two sections. Firstly, the practice section is done. Next, the child cuts out the picture and then pastes it into the book. After the completion of the program, the researcher will collect the books in order to analyse the progress of cutting. The child can take home every 5^{th} picture they cut out for the meantime and at the end of the study, they will receive their whole cutting book to take home. The book will thus contain pictures 1 – 4, 6 – 9, 11 – 14, 16 – 19, 21 – 24, 26 – 29, 31 – 34, 36 – 39, 41.

Scissor grip

- Thumb through top loop
- Middle finger through bottom loop
- Index finger helps hold the bottom loop steady
- The scissor points away from the body

“The correct scissor position is with the thumb and middle finger in the handles of the scissors, the index finger on the outside of the handle to stabilize, with the fingers four and five curled into the palm.” (16)

Position of the ‘scissor-hand’

- Midposition
- Elbow held loosely next to trunk

Stabilising Hand

- The position of the stabilising hand is in mid-position, i.e. the thumb at the top
- The bulk of the picture is held in the stabilising hand i.e. the edge is cut off, rather than the child holding the edge

Cutting

- Encourage the child to use most of the blade when cutting (i.e. no snipping)
- To avoid a jagged edge, the child is encouraged to start off exactly where the previous line ended.
- The child has to be able to see the line when cutting; if the child cannot see the line, he is not cutting ON the line. A right-handed child will look on the left side of the blade and vice versa.
- Once finished cutting on a line, the line can be seen on either side of the cut.
- A right-handed child cuts anti-clockwise around the picture and a left-handed child cuts clockwise around a picture.
- Encourage slow closing of the scissors, in order to be able to manipulate the paper with the assistive hand effectively.
- The assistive hand holds the shape to be cut out and the child cuts around the shape (i.e. the child does not hold the off-cuts)
- Encourage the child to manipulate the paper with the assistive hand and also to adjust the positioning of the hand while cutting. The assistive hand can be

moved, especially when changing the cutting direction and it should be held close to the position of the scissors

Practice section

The following practice sections are placed in the plastic folders provided:
Practice 1 (straight lines); practice 8 (wide zig-zag); practice 11 (square spiral); practice 12 (narrow zig-zag); practice 14 (frog jumps); practice 18 (gentle waves); practice 22 (straight lines with circles); practice 25 (high waves); practice 28 (upper and lower circles joined); practice 31 (spiral); practice 37 (circles)

Straight lines:
The right handed child starts to cut from the right side of the page. The left-handed child starts to cut from the left. The page may need to be turned so that the thick black line is at the correct side. (This is the first line to be cut).

Zig-zags:
Encourage the child to close the scissors in the corner i.e. try not to over-shoot.

Square spiral:
The two spirals (mirror-images) are separated by cutting on the line between them. The right handed child cuts from the right side i.e. the assistive hand holds the spiral and the left-handed child cuts from the left. Only one spiral is cut out.

Frog jumps:
Encourage the child to close the scissors and while doing this, manipulate the paper. Cut from the thick waves to the thinner waves. Close the scissors in the joins.

Waves:
Slowly close the scissors and while doing this, manipulate the paper with the assistive hand, so that the black line can be seen at all times.
Top straight line with bottom circles cut out:

Encourage the child to close the scissors in every corner, before changing direction.

Top and bottom circles joined in a pattern:
Encourage constant manipulation of the paper. The assistive hand is doing the bulk of the movement and should be in constant motion.

Spiral:
Encourage the child to turn the paper while closing the scissors slowly. The right-handed child cuts the spiral from the right towards the middle and the left-handed child cuts the spiral from the left towards the middle. Only one spiral is cut out per child.

Circles:
The right handed child cuts the circles from the right towards the middle and the left-handed child from the left towards the middle. Only half of the circles are cut out per child.

For any queries regarding the program you are most welcome to phone me on 678-8292 or 076 390 8178.

Kind Regards,

Ingrid Ratcliffe

APPENDIX T

ADJUSTMENTS TO THE TEACHER INSTRUCTION SHEET

Cutting

- When teaching corners, let the child close the scissors in the corner, before changing direction i.e. the child plans how wide to open the scissors when approaching a corner.
- When cutting out a circle, children should make sure that they see the line all of the time, as they often tend to cut smaller and smaller, moving into the circle. If this is observed, rather encourage them to cut slightly more on the outside of the circle, until they are able to maintain the scissors on the line.

Practice section

- Various patterns are represented as mirror-images. (Square spiral, spiral, circular patterns) Only one of the images is cut out, as left- and right-handed children approach cutting tasks from opposite sides. Thus a right-handed child cuts anti-clockwise around the design and a left-handed child cuts clockwise around a design.

APPENDIX U

THERAPIST FOCUS GROUP: COMMENTS ON INITIAL CUTTING PROGRAM

The following comments were made by the therapists:

Picture 5 seems easier than 4.

Picture 7 is too hard

Picture 8 is visually disturbing

Picture 11 is hard

Picture 15 is not compatible with the practice exercise

Picture 21 waves are difficult

Picture 25 practice is easier than 17

Picture 42 – 44 easier than 41

Circles are easier than wavy lines

Pictures are appropriate. The practice is a good idea and the lines are graded well.

Picture 40 is too difficult

The practice with hoops is too difficult

Some of the grading seems confused.

Picture 4 is too difficult

Picture 5 could have a wider mast

Picture 8 is a boring picture

Pictures generally could be more exciting – perhaps create ‘cartoon images’.

White paper seems boring and possibly coloured paper should be used.

Perhaps all of the individual pictures could become part of a greater picture or mural.

One could introduce inexpensive alternatives, for instance cutting cardboard from milk/Tropica bottles.

APPENDIX V

PARENT CONSENT FORM AND QUESTIONNAIRE

Dear Parent(s)

I am an Occupational Therapist in the process of conducting my Doctorate on the development of skills in young children. Your child's school has been chosen through stratified sampling to take part in my research project. I shall be most grateful if you would allow your child to participate in this research.

The objective of my study is to evaluate some fine motor skills in normal Grade 0 children to provide information on what normal children do.
In order for me to gain an understanding of your child's fine motor development, I would like to ask you to please fill out a one-page questionnaire before the research commences.

The research involves taking your child out of the classroom situation for about 10 minutes to complete various fine motor tasks such as threading or folding. This will be done 3 times in the year; in May, July and November. The school has granted permission for the class teacher to implement a Graded fine motor program with the whole class for two months. There are no costs or risks involved. Results are confidential and no names will be used in the documentation. The school will not receive individual reports on children.

Participation in the research project is voluntary. Your child may withdraw at any stage, should you so wish. Please confirm your consent for this research as detailed below.

Yours sincerely
Ingrid Ratcliffe

I, the undersigned allow ________________________________ (Child's name)
to take part in this research project.

(Signature) (Date)

PARENT QUESTIONNAIRE

Child's name: ____

Date of Birth: ____

Thank you for taking the time to fill out this questionnaire. The following questions help me, to gain an understanding of your child's fine motor development. Please answer the questions as honestly as possible. No names will be used in any documentation and information will be treated confidentially.

1. Did your child attend a nursery school before going to Grade 0? Yes / No

Name ____

Period ____

2. Where does your child generally go when school closes at 1pm (please tick)

    Home ________ Aftercare __________ Other _______________

3. Do you (mother) work

    Full-time ______ Part-time ___________ Other _______________

4. Do you (father) work

    Full-time ______ Part-time ___________ Other _______________

5. What activities do you (mother and/or father) do with your child?

    Extra murals ____

    ____

    At home ____

    ____

6. How much time do you spend with your child on average per day?

    ____

7. Do you have :

colouring pencils	Yes / no
Paintbrush and paint	Yes / no
Paper	Yes / no
Beads	Yes / no
Scissors	Yes / no
Kokis	Yes / no
Playdough	Yes / no

Is your child allowed to use these on his/her own? Yes / no

Thank you for your time!!

Kind Regards,
Ingrid Ratcliffe

TEACHER QUESTIONNAIRE

Ingrid Ratcliffe
P O Box 9135
Devon Valley
1715

Dear

Please take the time to fill out this questionnaire at the end of implementing the program.

School: ________________________________Date:________________

Group A / Group B (circle the appropriate)

Please score a 1 -10: 1=not at all; 10=most definitely

Did you enjoy using this program	1 2 3 4 5 6 7 8 9 10
Did you feel that 4-5 times per week was too much	1 2 3 4 5 6 7 8 9 10
Did it save you on some preparation time	1 2 3 4 5 6 7 8 9 10
Did you feel your children's cutting ability improved	1 2 3 4 5 6 7 8 9 10
Were you stressed having to use the program	1 2 3 4 5 6 7 8 9 10
Did you find the pictures appropriate	1 2 3 4 5 6 7 8 9 10

Comments:

____

____

____

____

____

Thank you for your valued input.
Ingrid Ratcliffe

APPENDIX W

ETHICAL CLEARANCE CERTIFICATE

APPENDIX X

SCHOOL CONSENT FORM

Ingrid Ratcliffe
(011) 678-8292
ratcliffe@worldonline.co.za
2 February 2006

Dear

I am an Occupational Therapist in the process of conducting research for a Doctorate. Your school has been chosen through stratified sampling to take part in the research project. I shall be most grateful if you are interested in participating in the research and thank you for your time.

The objective of the research study is to evaluate some fine motor skills in normal grade 0 children before and after implementation of a graded fine motor program.

This entails children from the grade 0 classes. If their parents agree, and the children don't object, they will be divided into two groups (according to classes) - one as the experimental group and one as the control group. All groups will undergo testing of fine motor skills in May, July and November. The researcher will test each child individually, looking at bilateral skills such as threading or folding. The test takes approximately 10 minutes per child. There are no costs or risks involved.

Once all the children have been tested, teachers who have agreed to participate will carry out the program. They will be presented with a fine motor program, running over 40 sessions. This should take place 5 times per week for approximately 10 weeks, so that the program has been completed before the next assessment takes place. The program should be done in the first part of the day, before first break. The experimental group will do the program from May until July and the control group from September until October. The program will take approximately 15 minutes per session. Details on how to run the program will be given to each teacher. There are no costs or risks involved.

Children should benefit from the fine motor program. Should it prove to develop the skill in children, it will be made available to the school once the research has been completed.

Participation in this research project is voluntary, with no consequences, should you choose not to participate. Your school may decide to withdraw at any time, also without any consequence. Please confirm your consent for this research as detailed below.

Yours sincerely

Ingrid Ratcliffe

I, the undersigned allow ________________________________ (school's name) to take part in this research project. The graded program will be carried out within the stipulated time period.

(Signature) (Date)

APPENDIX Y

TEACHER CONSENT

Ingrid Ratcliffe
P O Box 9135
Devon Valley
1715

26 September 2003

(011) 678-8292
ratcliffe@worldonline.co.za

Dear

I am an Occupational Therapist in the process of conducting research for a Doctorate. Your principal has granted permission to do research at your school next year. I shall be most grateful if you are interested in this research project and thank you for your help. I would like to ask you to implement a fine motor program with the children in your class. I hope that you will find the program interesting and am looking forward to your response to it. Should you have any questions, please do not hesitate to contact me at the numbers above.

Please discuss with your principal if you are part of group A, or part of the group B. All participating children will be tested individually for 10 minutes; once in March, once in June and lastly in September. Dates will be forwarded to you closer to the time. After the assessment, you will be given the program to implement in the classroom.

The program should be done 4 – 5 times per week, over a period of 3 months. It should be done at the beginning of the day before first break and should take approximately 15 minutes. Group A does this from April until June and Group B from August until September.

The program is self-explanatory and will have a brief introduction on the motor skills that are expected. No preparation is expected on your part. Please could you also take the time to fill out the questionnaire, which will assist me in analysing the impact of the program on your routine.

Thank you for your time taken to implement the program!!

Kind regards

Ingrid Ratcliffe

APPENDIX Z

SCORING OF PRACTICE COMPONENT OF THE SASSP

The patterns in the practice component of the SASSP varied. They always (with exception of the circle) started off with a 3mm line thickness, which was then decreased to 2mm and 1mm. The teacher was asked to collect the first sample of each pattern. All patterns had 3mm line thickness only, with the exception of the square spiral, the 70 degree zigzags and the circles. The square spiral started off with 3mm, then 2mm and finally 1mm. The 70 degree zigzag had 2 lines with 3mm, one with 2mm and two with 1mm. The two circles were 2mm.

	The patterns included:	Lines that were cut per pattern:
8.	Straight lines	8
9.	Zigzags (130 degree)	6
10.	Square spiral (90 degree)	9
11.	Zigzags (70 degree)	5
12.	Frog-jumps	5
13.	Gentle wide wave	4
14.	Top straight line with bottom circles cut out	5
15.	High waves	5
16.	Top and bottom circles joined in a pattern	4
17.	Spirals	1
18.	Circles	2

The measurement was done in the following way:
For each child, the patterns were placed on a yellow board. This allowed for some contrast and it was easier to see where the child had cut on the line. Looking at the

straight line for instance, all of the lines cut out were placed next to each other. If all of the lines were cut on the black line, the child scored 100%. If only four of the lines were cut on the line, 50% was scored. If part of a line was not cut on the line, the percentage of this in relation to the whole was estimated. Thus, if half of one line and another half of another line was not cut, this was one complete line not cut, thus scoring about 85%.

APPENDIX AA

SCORING OF PICTURE COMPONENT OF THE SASSP

Each child received a ‘program book’. This was a small A5 book with blank pages, so that children would be able to stick their pictures into this book. Every 5^{th} picture was sent home, as a more instant reward for their effort. Thus, the book contained pictures 1-4, 6-9, 11-14, 16-19, 20-24, 26-29, 30-34, 36-39 and 41.

The measurement was done in the following way:
This was done using a point system. Each picture was allocated a certain amount of points (total points). One point was scored with each change of direction in a picture. This was also done for corners, as well as for curved paths. A ‘sharp curve’ was equated with a corner. A master copy for this point system was used when scoring the individual pictures. The point scores were then converted to percentage scores to give an idea, how accurately the children were able to cut throughout the program. If the child for instance scored 6 points for the flag, this was converted to a percentage of 100. If three points were scored, this was converted to 50%. Thus the points scored divided by the maximum points times 100 equalled the percentage.

Pictures included:	Maximum points per picture:
Flag	6
Book	6
House	7
Boat	10
Tree	19
Fence	40
Sun	20
Castle	30

Balloon	8
Owl	14
Kite	31
Car	11
Flower	11
Hippo	13
Tortoise	7
Tree	7
Elephant	10
Bird	16
Dog	16
Pear	10
Ladybird	17
Duck	18
Camel	25
Apple	11
Parrot	14
Cat	27
Mouse	10
Snail	14
Fish	12
Squirrel	18
Hen	33
Croc	46
Horse	29

APPENDIX BB

PARENT RESPONSES

Table BB1 Summary of Parent Questionnaires

	School 1	School 2	School 3
Participants	44	39	57
Nursery School			
Yes	39	39	37
No	5	0	20
After School			
Aftercare	20	2	0
Sports		2	
Mother (work)			
Full-time	38	5	17
Part-time	2	22	16
No work	4	12	23
Father (work)			
Full-time	38	36	23
Part-time	1	3	8
No work	1	0	9
No dad	4		17
No mom			1
Extra murals			
karate	7	6	
soccer	2	9	
swimming	5	25	
golf		2	
tennis		9	
ballet	3	14	
playball		8	
games		5	
bicycle		1	
computers	3	1	
music		1	
cricket		1	
judo		3	
art		2	
tap		1	
horseriding		1	
gymnastic		2	
kumon		2	
ball skills	5		
pottery	2		
None	24		57

Home	School 1	School 2	School 3
swimming	9	12	
bicycle	9	12	
reading	10	16	12
puzzles	8	14	6
ball	7	12	4
games	7	8	4
art		8	
cricket		6	
trampoline		5	
colouring	14	9	
soccer	5	3	10
tennis		3	
golf		3	
baking		5	
computers	3	2	1
crafts	6		
writing			13
singing			15
dance			2
cutting			5
skipping			1
cards			1
marbles			1
Materials			
colouring pencils	44	39	39
paintbrush and paint	32	35	6
paper	44	38	48
beads	14	26	8
scissors	43	39	47
kokis	38	38	29
playdough	29	33	11
use on own	42	39	31

APPENDIX CC

PERCENTILE SCORES

The formula for computing the median is as follows:

$$Mdn = \underline{ll + (\ (N)\ (50\%) - fc)\ i}$$
$$(\ fi)$$

ll = exact lower limit of the interval containing the median

fc = sum of all the frequencies below this interval

fi = frequency in the interval containing the median

N = number of cases

i = size of interval

(60)

Table CC1 Percentile calculations for School 1A, Assessment 1 (Square)

School 1	**Group A**			
	Ass 1			
Square	**f**	**Cum f**	**Cum% f**	**Median**
100	7	21	100	
90-99	2	14	66.66667	
80-89	5	12	57.14286	**86.5**
70-79	2	7	33.33333	
60-69	2	5	23.80952	
50-59	-			
40-49	2	3	14.28571	
30-39	1	1	4.761905	
20-29	-			
10-19	-			
0-9	-			

Table CC2 Percentile calculations for School 1A, Assessment 1 (Circle)

School 1	Group A			
	Ass 1			
Circle	f	Cum f	Cum% f	Median
100	1	21	100	
90-99	5	20	95.2381	
80-89	3	15	71.42857	
70-79	-			
60-69	2	12	57.14286	**62**
50-59	1	10	47.61905	
40-49	1	9	42.85714	
30-39	3	8	38.09524	
20-29	3	5	23.80952	
10-19	2	2	9.52381	
0-9	-			

Table CC3 Percentile calculations for School 1A, Assessment 2 (Square)

School 1	Group A			
	Ass 2			
Square	f	Cum f	Cum% f	Median
100	12	21	100	**100**
90-99	2	9	42.85714	
80-89	3	7	33.33333	
70-79	1	4	19.04762	
60-69	-			
50-59	-			
40-49	-			
30-39	3	3	14.28571	
20-29	-			
10-19	-			
0-9	-			

Table CC4 Percentile calculations for School 1A, Assessment 2 (Circle)

School 1	Group A			
	Ass 2			
Circle	f	Cum f	Cum% f	Median
100	8	21	100	
90-99	3	13	61.90476	**91.2**
80-89	2	10	47.61905	
70-79	3	8	38.09524	
60-69	0	5	23.80952	
50-59	0	5	23.80952	
40-49	0	5	23.80952	
30-39	0	5	23.80952	
20-29	1	5	23.80952	
10-19	4	4	19.04762	
0-9	0	0	0	

Table CC5 Percentile calculations for School 1A, Assessment 3 (Square)

School 1	Group A			
	Ass 3			
Square	f	Cum f	Cum% f	Median
100	13	21	100	**100**
90-99	2	8	38.09524	
80-89	3	6	28.57143	
70-79	0	3	14.28571	
60-69	0	3	14.28571	
50-59	1	3	14.28571	
40-49	1	2	9.52381	
30-39	0	1	4.761905	
20-29	1	1	4.761905	
10-19	0	0	0	
0-9	0	0	0	

Table CC6 Percentile calculations for School 1A, Assessment 3 (Circle)

School 1	Group A			
	Ass 3			
Circle	f	Cum f	Cum% f	Median
100	5	21	100	
90-99	6	16	76.19048	**90.3**
80-89	6	10	47.61905	
70-79	2	4	19.04762	
60-69	0	2	9.52381	
50-59	1	2	9.52381	
40-49	1	1	4.761905	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC7 Percentile calculations for School 1B, Assessment 1 (Square)

School 1	Group B			
	Ass 1			
Square	f	Cumulative	Cum% f	Median
100	7	23	100	
90-99	2	16	69.56522	
80-89	4	14	60.86957	**83.25**
70-79	1	10	43.47826	
60-69	2	9	39.13043	
50-59	4	7	30.43478	
40-49	2	3	13.04348	
30-39	0	1	4.347826	
20-29	0	1	4.347826	
10-19	0	1	4.347826	
0-9	1	1	4.347826	

Table CC8 Percentile calculations for School 1B, Assessment 1 (Circle)

School 1	Group B			
	Ass 1			
Circle	F	Cumulative	Cum% f	Median
100	0			
90-99	3	23	100	
80-89	3	20	86.95652	
70-79	3	17	73.91304	
60-69	3	14	60.86957	**61.2**
50-59	2	11	47.82609	
40-49	1	9	39.13043	
30-39	3	8	34.78261	
20-29	0	5	21.73913	
10-19	4	5	21.73913	
0-9	1	1	4.347826	

Table CC9 Percentile calculations for School 1B, Assessment 2 (Square)

School 1	Group B			
	Ass 2			
Square	f	Cumulative	Cum% f	Median
100	3	21	100	
90-99	8	18	85.71429	**90.1**
80-89	3	10	47.61905	
70-79	2	7	33.33333	
60-69	2	5	23.80952	
50-59	0	3	14.28571	
40-49	1	3	14.28571	
30-39	1	2	9.52381	
20-29	1	1	4.761905	
10-19	0	0	0	
0-9	0	0	0	

Table CC10 Percentile calculations for School 1B, Assessment 2 (Circle)

School 1	Group B			
	Ass 2			
Circle	f	Cumulative	Cum% f	Median
100	2	21	100	
90-99	4	19	90.47619	
80-89	1	15	71.42857	
70-79	3	14	66.66667	
60-69	2	11	52.38095	**67**
50-59	0	9	42.85714	
40-49	0	9	42.85714	
30-39	3	9	42.85714	
20-29	1	6	28.57143	
10-19	2	5	23.80952	
0-9	3	3	14.28571	

Table CC11 Percentile calculations for School 1B, Assessment 3 (Square)

School 1	Group B			
	Ass 3			
Square	f	Cumulative	Cum% f	Median
100	7	20	100	
90-99	9	13	65	**96.2**
80-89	3	4	20	
70-79	1	1	5	
60-69	0	0	0	
50-59	0	0	0	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC12 Percentile calculations for School 1B, Assessment 3 (Circle)

School 1	Group B			
	Ass 3			
Circle	f	Cumulative	Cum% f	Median
100	6	20	100	
90-99	4	14	70	
80-89	3	10	50	80.5
70-79	0	7	35	
60-69	1	7	35	
50-59	1	6	30	
40-49	0	5	25	
30-39	1	5	25	
20-29	3	4	20	
10-19	1	1	5	
0-9	0	0	0	

Table CC13 Percentile calculations for School 2A, Assessment 1 (Square)

School 2	Group A			
	Ass 1			
Square	f	Cum f	Cum% f	Median
100	7	22	100	
90-99	3	15	68.18182	
80-89	4	12	54.54545	**87**
70-79	3	8	36.36364	
60-69	1	5	22.72727	
50-59	3	4	18.18182	
40-49	1	1	4.545455	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC14 Percentile calculations for School 2A, Assessment 1 (Circle)

School 2	Group A			
	Ass 1			
Circle	f	Cum f	Cum% f	Median
100	2	22	100	
90-99	5	20	90.90909	
80-89	5	15	68.18182	**81.5**
70-79	1	10	45.45455	
60-69	1	9	40.90909	
50-59	3	8	36.36364	
40-49	2	5	22.72727	
30-39	2	3	13.63636	
20-29	1	1	4.545455	
10-19	0	0	0	
0-9	0	0	0	

Table CC15 Percentile calculations for School 2A, Assessment 2 (Square)

School 2	Group A			
	Ass 2			
Square	f	Cum f	Cum% f	Median
100	9	21	100	
90-99	5	12	57.14286	**96.5**
80-89	4	7	33.33333	
70-79	2	3	14.28571	
60-69	0	1	4.761905	
50-59	1	1	4.761905	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC16 Percentile calculations for School 2A, Assessment 2 (Circle)

School 2	Group A			
	Ass 2			
Circle	f	Cum f	Cum% f	Median
100	9	21	100	
90-99	1	12	57.14286	
80-89	4	11	52.38095	**88.25**
70-79	2	7	33.33333	
60-69	2	5	23.80952	
50-59	0	3	14.28571	
40-49	0	3	14.28571	
30-39	0	3	14.28571	
20-29	3	3	14.28571	
10-19	0	0	0	
0-9	0	0	0	

Table CC17 Percentile calculations for School 2A, Assessment 3 (Square)

School 2	Group A			
	Ass 3			
Square	f	Cum f	Cum% f	Median
100	12	21	100	**100**
90-99	4	9	42.85714	
80-89	2	5	23.80952	
70-79	0	3	14.28571	
60-69	2	3	14.28571	
50-59	0	1	4.761905	
40-49	1	1	4.761905	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC18 Percentile calculations for School 2A, Assessment 3 (Circle)

School 2	Group A			
	Ass 3			
Circle	f	Cum f	Cum% f	Median
100	9	21	100	
90-99	2	12	57.14286	**92**
80-89	3	10	47.61905	
70-79	2	7	33.33333	
60-69	3	5	23.80952	
50-59	1	2	9.52381	
40-49	0	1	4.761905	
30-39	0	1	4.761905	
20-29	1	1	4.761905	
10-19	0	0	0	
0-9	0	0	0	

Table CC19 Percentile calculations for School 2B, Assessment 1 (Square)

School 2	Group B			
	Ass 1			
Square	f	Cum f	Cum% f	Median
100	12	23	100	**100**
90-99	7	11	47.82608	
80-89	3	4	17.39130	
70-79	0	1	4.347826	
60-69	1	1	4.347826	
50-59	0	0	0	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC20 Percentile calculations for School 2B, Assessment 1 (Circle)

School 2	Group B			
	Ass 1			
Circle	f	Cum f	Cum% f	Median
100	6	23	100	
90-99	6	17	73.91304	**90.3**
80-89	2	11	47.82608	
70-79	0	9	39.13043	
60-69	1	9	39.13043	
50-59	1	8	34.78261	
40-49	0	7	30.43478	
30-39	2	7	30.43478	
20-29	3	5	21.73913	
10-19	2	2	8.695652	
0-9	0	0	0	

Table CC21 Percentile calculations for School 2B, Assessment 2 (Square)

School 2	Group B			
	Ass 2			
Square	f	Cum f	Cum% f	Median
100	13	23	100	**100**
90-99	6	10	43.47826	
80-89	1	4	17.39130	
70-79	1	3	13.04347	
60-69	1	2	8.695652	
50-59	0	1	4.347826	
40-49	0	1	4.347826	
30-39	0	1	4.347826	
20-29	1	1	4.347826	
10-19	0	0	0	
0-9	0	0	0	

Table CC22 Percentile calculations for School 2B, Assessment 2 (Circle)

School 2	Group B			
	Ass 2			
Circle	f	Cum f	Cum% f	Median
100	8	23	100	
90-99	4	15	65.21739	**90.75**
80-89	2	11	47.82608	
70-79	2	9	39.13043	
60-69	1	7	30.43478	
50-59	0	6	26.08695	
40-49	0	6	26.08695	
30-39	2	6	26.08695	
20-29	2	4	17.39130	
10-19	1	2	8.695652	
0-9	1	1	4.347826	

Table CC23 Percentile calculations for School 2B, Assessment 3 (Square)

School 2	Group B			
	Ass 3			
Square	f	Cum f	Cum% f	Median
100	16	23	100	**100**
90-99	2	7	30.43478	
80-89	3	5	21.73913	
70-79	1	2	8.695652	
60-69	1	1	4.347826	
50-59	0	0	0	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC24 Percentile calculations for School 2B, Assessment 3 (Circle)

School 2	Group B			
	Ass 3			
Circle	f	Cum f	Cum% f	Median
100	14	23	100	**100**
90-99	5	9	39.13043	
80-89	2	4	17.39130	
70-79	0	2	8.695652	
60-69	1	2	8.695652	
50-59	0	1	4.347826	
40-49	0	1	4.347826	
30-39	0	1	4.347826	
20-29	1	1	4.347826	
10-19	0	0	0	
0-9	0	0	0	

Table CC25 Percentile calculations for School 3A, Assessment 1 (Square)

School 3	Group A			
	Ass 1			
Square	f	Cum f	Cum% f	Median
100	1	38	100	
90-99	0	37	97.36842	
80-89	1	37	97.36842	
70-79	2	36	94.73684	
60-69	1	34	89.47368	
50-59	1	33	86.84210	
40-49	2	32	84.21052	
30-39	5	30	78.94736	
20-29	2	25	65.78947	
10-19	4	23	60.52631	
0-9	19	19	50	**9**

Table CC26 Percentile calculations for School 3A, Assessment 1 (Circle)

School 3	Group A			
	Ass 1			
Circle	f	Cum f	Cum% f	Median
100	0			
90-99	0			
80-89	1	38	100	
70-79	1	37	97.36842	
60-69	3	36	94.73684	
50-59	4	33	86.84210	
40-49	0	29	76.31578	
30-39	3	29	76.31578	
20-29	2	26	68.42105	
10-19	5	24	63.15789	
0-9	19	19	50	**9**

Table CC27 Percentile calculations for School 3A, Assessment 2 (Square)

School 3	Group A			
	Ass 2			
Square	f	Cum f	Cum% f	Median
100	13	35	100	
90-99	8	22	62.85714	**93.9**
80-89	4	14	40	
70-79	1	10	28.57142	
60-69	2	9	25.71428	
50-59	1	7	20	
40-49	0	6	17.14285	
30-39	1	6	17.14285	
20-29	0	5	14.28571	
10-19	3	5	14.28571	
0-9	2	2	5.714285	

Table CC28 Percentile calculations for School 3A, Assessment 2 (Circle)

School 3	Group A			
	Ass 2			
Circle	f	Cum f	Cum% f	Median
100	7	35	100	
90-99	8	28	80	
80-89	5	20	57.14285	**84.5**
70-79	3	15	42.85714	
60-69	1	12	34.28571	
50-59	1	11	31.42857	
40-49	1	10	28.57142	
30-39	5	9	25.71428	
20-29	2	4	11.42857	
10-19	0	2	5.714285	
0-9	2	2	5.714285	

Table CC29 Percentile calculations for School 3A, Assessment 3 (Square)

School 3	Group A			
	Ass 3			
Square	f	Cum f	Cum% f	Median
100	9	29	100	
90-99	7	20	68.96551	**91.6**
80-89	3	13	44.82758	
70-79	3	10	34.48275	
60-69	1	7	24.13793	
50-59	2	6	20.68965	
40-49	1	4	13.79310	
30-39	0	3	10.34482	
20-29	0	3	10.34482	
10-19	0	3	10.34482	
0-9	3	3	10.34482	

Table CC30 Percentile calculations for School 3A, Assessment 3 (Circle)

School 3	Group A			
	Ass 3			
Circle	f	Cum f	Cum% f	Median
100	7	29	100	
90-99	3	22	75.86208	
80-89	2	19	65.51724	
70-79	4	17	58.62068	**73.25**
60-69	5	13	44.82758	
50-59	0	8	27.58620	
40-49	0	8	27.58620	
30-39	2	8	27.58620	
20-29	1	6	20.68965	
10-19	3	5	17.24137	
0-9	2	2	6.896551	

Table CC31 Percentile calculations for School 3B, Assessment 1 (Square)

School 3	Group B			
	Ass 1			
Square	f	Cum f	Cum% f	Median
100	0			
90-99	1	22	100	
80-89	1	21	95.45454	
70-79	1	20	90.90909	
60-69	0	19	86.36363	
50-59	0	19	86.36363	
40-49	2	19	86.36363	
30-39	2	17	77.27272	
20-29	1	15	68.18181	
10-19	4	14	63.63636	**12**
0-9	10	10	45.45454	

Table CC32 Percentile calculations for School 3B, Assessment 1 (Circle)

School 3	Group B			
	Ass 1			
Circle	f	Cum f	Cum% f	Median
100	0			
90-99	2	22	100	
80-89	1	20	90.90909	
70-79	0	19	86.36363	
60-69	0	19	86.36363	
50-59	0	19	86.36363	
40-49	1	19	86.36363	
30-39	0	18	81.81818	
20-29	3	18	81.81818	
10-19	1	15	68.18181	
0-9	14	14	63.63636	**7.9**

Table CC33 Percentile calculations for School 3B, Assessment 2 (Square)

School 3	Group B			
	Ass 2			
Square	f	Cum f	Cum% f	Median
100	2	22	100	
90-99	1	20	90.90909	
80-89	0	19	86.36363	
70-79	0	19	86.36363	
60-69	1	19	86.36363	
50-59	5	18	81.81818	
40-49	1	13	59.09090	
30-39	1	12	54.54545	
20-29	1	11	50	**29.5**
10-19	2	10	45.45454	
0-9	8	8	36.36363	

Table CC34 Percentile calculations for School 3B, Assessment 2 (Circle)

School 3	Group B			
	Ass 2			
Circle	f	Cum f	Cum% f	Median
100	0			
90-99	1	22	100	
80-89	2	21	95.45454	
70-79	0	19	86.36363	
60-69	3	19	86.36363	
50-59	1	16	72.72727	
40-49	0	15	68.18181	
30-39	2	15	68.18181	
20-29	1	13	59.09090	
10-19	2	12	54.54545	**14.5**
0-9	10	10	45.45454	

Table CC35 Percentile calculations for School 3B, Assessment 3 (Square)

School 3	Group B			
	Ass 3			
Square	f	Cum f	Cum% f	Median
100	5	19	100	
90-99	2	14	73.68421	
80-89	2	12	63.15789	
70-79	3	10	52.63157	**77.8**
60-69	4	7	36.84210	
50-59	1	3	15.78947	
40-49	1	2	10.52631	
30-39	1	1	5.263157	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table CC36 Percentile calculations for School 3B, Assessment 3 (Circle)

School 3	Group B			
	Ass 3			
Circle	f	Cum f	Cum% f	Median
100	4	19	100	
90-99	2	15	78.94736	
80-89	2	13	68.42105	
70-79	2	11	57.89473	**72**
60-69	3	9	47.36842	
50-59	1	6	31.57894	
40-49	0	5	26.31578	
30-39	3	5	26.31578	
20-29	2	2	10.52631	
10-19	0	0	0	
0-9	0	0	0	

APPENDIX DD

IMPROVEMENT IN SCISSOR SKILLS

Table DD1 P-values for Cutting Aspects

	Grip	Motion	Approach	Accuracy	Cut Time
Groups /category	0.271	0.330	0.098	0.017	0.105
Groups/category *school	0.301	0.358	0.098	0.059	0.187
Ass number	0	0	0	0	0.000
Ass number *school	0.024	0.001	0.000	0	0.584
Ass number * grp/category	0	0	0.002	0	0.378

Values where p ≤ 0.05 are statistically significant

This table shows the p-values for cutting aspects. Results show statistical significance for all of the five cutting aspects for the assessment number in each school. It also shows statistical significance in improvement of Group A and Group B in all aspects, except for cutting time.

Table DD2 Mean Percentage Scores (x) and Standard Deviation (SD) for Scissor Skills

Category	School	Group A					Group B				
		Ass 1		Ass 2		1/2	Ass 2		Ass 3		2/3
		x	SD	x	SD	Diff	x	SD	x	SD	Diff
Scissor Grip	1	83	11	89	7	**6**	88	8	90	6	**2**
	2	79	13	94	10	**15**	88	9	91	7	**3**
	3	73	12	84	13	**11**	75	14	82	11	**7**
Cut Motion	1	51	15	78	15	**27**	60	17	75	14	**15**
	2	58	16	78	11	**20**	67	16	76	14	**9**
	3	41	15	56	19	**15**	43	17	70	17	**27**
Cut Approach	1	58	12	70	11	**12**	59	10	67	10	**8**
	2	63	11	68	15	**5**	66	14	76	13	**10**
	3	36	16	54	16	**18**	41	19	57	14	**16**
Cut Accuracy	1	71	25	81	25	**10**	68	25	83	17	**15**
	2	79	20	87	17	**8**	82	23	94	13	**12**
	3	21	23	76	25	**55**	32	30	73	20	**41**
Cut Time	1	81	6	84	7	**3**	85	4	87	5	**2**
	2	85	4	83	3	**-2**	87	3	86	4	**-1**
	3	72	13	75	12	**3**	80	10	79	12	**-1**

This table shows the mean percentage scores and standard deviation scores before and after the program. The difference in mean percentage is also recorded. The highlighted cells in red show an improvement of greater than 10%.

APPENDIX EE

CHANGE IN SCISSOR SKILLS PRIOR TO INTERVENTION

Table EE1 Pre-Intervention Cutting Scores

		Group B	
Category	School	Ass1	Ass 2
Scissor Grip	1	84	88
	2	87	88
	3	76	75
Cutting Motion	1	57	60
	2	70	67
	3	46	43
Cutting Approach	1	53	59
	2	65	66
	3	33	41
Accuracy	1	66	68
	2	83	82
	3	22	32
Time	1	79	85
	2	82	87
	3	78	80

APPENDIX FF

SKILL RETENTION SCORES

Table FF1 Difference in Mean Percentage Scores for Group A directly after the scissor skills program and 3 months later

		Group A
	School	**Score Difference in %**
Scissor Grip	**1**	**1**
	2	**0**
	3	**6**
Cut Motion	**1**	**2**
	2	**-3**
	3	**7**
Cut Approach	**1**	**0**
	2	**0**
	3	**5**
Cut Accuracy	**1**	**7**
	2	**1**
	3	**0**
Cut Time	**1**	**1**
	2	**2**
	3	**2**

All scores improve, except for one, highlighted in blue.

APPENDIX GG

TIMING WITHIN THE YEAR

Table GG1 Improvement in Mean Percentage Scores

		Group A	Group B
		Improve	Improve
Scissor Grip	1	**+6**	**+2**
	2	**+15**	**+3**
	3	**+11**	**+7**
Cut Motion	1	**+27**	**+15**
	2	**+20**	**+9**
	3	**+15**	**+27**
Cut Approach	1	**+12**	**+8**
	2	**+5**	**+10**
	3	**+18**	**+16**
Cut Accuracy	1	**+10**	**+15**
	2	**+8**	**+12**
	3	**+55**	**+41**
Cut Time	1	**+3**	**+2**
	2	**-2**	**-1**
	3	**+3**	**-1**

Improvement in mean percentage scores are recorded for Group A and Group B, before and after the scissor skills program. Highlighted areas in red show the improvement in the first half of the year. Highlighted areas in blue show the improvement in the second half of the year.

APPENDIX HH

CONFIDENCE INTERVAL BETWEEN GROUP A AND GROUP B

Table HH1 Confidence Intervals between Group A and Group B pre- and post- intervention

		Group A		Group B	
	School	Ass 1-2n	Ass 2-3	Ass 1-2	Ass 2-3
Name	1	ns	ns	ns	ns
	2	ns	ns	ns	ns
	3	ns	ns	ns	ns
Object	1	$p \leq 0.05$	ns	ns	ns
	2	$p \leq 0.05$	ns	ns	ns
	3	ns	ns	ns	ns
Tearing	1	ns	ns	ns	$p \leq 0.05$
	2	ns	ns	$p \leq 0.05$	ns
	3	$p \leq 0.05$	ns	ns	ns
Beads	1	ns	ns	ns	ns
	2	ns	ns	ns	$p \leq 0.05$
	3	ns	ns	ns	ns
Shoelaces	1	ns	ns	$p \leq 0.05$	ns
	2	ns	ns	$p \leq 0.05$	ns
	3	ns	ns	ns	ns
Buttons	1	ns	$p \leq 0.05$	ns	ns
	2	ns	ns	ns	ns
	3	ns	ns	ns	ns

Values where $p \leq 0.05$ are statistically significant
ns=not significant

Table HH1 shows the confidence intervals between Group A and Group B for assessment 1-2 and assessment 2-3. Most intervals are not statistically significant. Group A showed statistically significant improvement from assessment 1 to 2 for drawing around an object (School 1 and School 2) as well as for tearing (School 3). Group A showed statistical improvement from assessment 2 to 3 for closing buttons (School 1). Group B showed statistical significance from assessment 1 to 2 for tearing (School 2), here not for improvement but for decrease in skill. Group B further showed statistically significant improvement for tying shoelaces (School 1 and School 2). Group B showed statistically significant improvement from assessment 2 to 3 for tearing (School 1) and threading beads (School 2).

Table HH2 Confidence Intervals at Assessment 1 between Group A and Group B

	School 1	School 2	School 3
Name	ns	ns	ns
Object	$p \leq 0.05$	ns	ns
Tearing	ns	ns	ns
Beads	ns	ns	ns
Shoelaces	ns	ns	ns
Buttons	ns	ns	ns
Grip	ns	$p \leq 0.05$	ns
Cutting Motion	ns	$p \leq 0.05$	ns
Cutting Approach	ns	ns	ns
Accuracy	ns	ns	ns
Cutting Time	ns	ns	ns

Values where $p \leq 0.05$ are statistically significant

ns=not significant

Table HH3 Confidence Intervals for Normal Bilateral Development

	Normal Bilateral development					
Ass 1/3	School 1A	School 2A	School 3A	School 1B	School 2B	School 3B
	CI p value	CI p value	CI p value	CI p value	CI p value	CI p value
Name	ns	ns	ns	ns	ns	ns
Draw around	0.05	0.05	ns	ns	ns	ns
Tearing	ns	ns	0.05	0.05	ns	ns
Threading	ns	ns	ns	0.05	0.05	ns
Shoelaces	0.05	ns	ns	0.05	0.05	ns
Buttons	0.05	ns	ns	ns	ns	ns

Significance $p \leq 0.05$

ns = not significant

APPENDIX II

EQUIVALENCE SCORES

Table II1 Equivalence Table

		Group A			Group B		
Category	**School**	**Ass 1**	**Ass 2**	**Gap**	**Ass 2**	**Ass 3**	**Gap**
Scissor Grip	1	+10	+5	-5	+13	+8	-5
	2	+6	+10	+4	+13	+9	-4
	3	73	84		75	82	
Cutting Motion	1	+10	+22	+12	+17	+5	-12
	2	+17	+22	+5	+24	+6	-18
	3	41	56		43	70	
Cut Approach	1	+22	+16	-6	+18	+10	-8
	2	+27	+14	-13	+25	+19	-6
	3	36	54		41	57	
Cut Accuracy	1	+50	+5	-45	+36	+10	-26
	2	+58	+11	-47	+50	+21	-29
	3	21	76		32	73	
Cutting Time	1	+9	+9	0	+5	+8	+3
	2	+13	+8	-5	+7	+7	0
	3	72	75		80	79	

Lowest Pre and Post Intervention Percentage Scores for Cutting Skills are shown in yellow. These were consistently scored by School 3, showing the lowest level of skill.

The difference towards the other schools is shown by the values above these. In red are those scores that are within 10% of the scores of School 3, i.e. where the gap has been closed.
The column showing ‘gap’ scores calculated the change in gap. A positive score (highlighted in blue) shows that the gap has increased and a negative score shows, that children were able to close the gap to a certain degree.

Table II2 Difference in gap between scores of School 3 and the other two schools given in percentage scores

		Scissor grip	Cutting motion	Cutting approach	Accuracy	Time
School 1	Group A	-5	+12	-6	-45	0
	Group B	-5	-12	-8	-26	+3
School 2	Group A	+4	+5	-13	-47	-5
	Group B	-4	-18	-6	-31	0

Table II2 illustrates the difference in gap between School 3 and School 1&2. For Group A, the difference in scores is calculated between assessment 1 and 2. For Group B the difference in scores are calculated between assessment 2 and 3. In all instances, School 3 is used as baseline, as it always presented with the weakest score. A gap that has decreased is indicated by a minus sign. As can be seen, most scores show a decrease in gap between School 3 and the other two schools. For cutting motion, Group A in both School 2 and School 3 increased the difference towards School 3 (by 12% and 5% respectively), indicating that they improved more through intervention, thus increasing the gap. Group A of School 2 also increased the gap in scissor grip (by 4%), as they showed greater improvement after intervention. Lastly, School 1B increased the gap toward School 3(by 3%) for the aspect of cutting time.

APPENDIX JJ

TRANSFER OF SKILLS SCORES

Table JJ1 Mean percentage scores

		Group A			Group B		
Category	School	Ass 1	Ass 2	Difference	Ass 2	Ass 3	Difference
Name writing	1	59	53	-6	61	64	3
	2	55	51	-4	53	58	5
	3	57	59	2	60	61	1
Drawing around Object	1	40	59	19	57	67	10
	2	45	63	18	60	60	0
	3	30	30	0	35	36	1
Tearing	1	23	35	12	21	38	17
	2	35	36	1	32	38	6
	3	17	29	12	17	28	11
Threading	1	54	60	6	57	62	5
	2	54	59	5	57	65	8
	3	48	49	1	49	50	1
Tying Shoelaces	1	22	41	19	55	54	-1
	2	48	52	4	68	75	7
	3	57	58	1	57	57	0
Buttoning	1	84	86	2	86	84	-2
	2	87	88	1	90	91	1
	3	83	84	1	86	85	-1

In this table, the mean percentage scores are recorded before and after implementation of the scissor skills program. The difference between the mean scores is also recorded. A positive difference shows an improvement in skill and a negative difference shows that the level of skill has deteriorated.

APPENDIX KK

SCORE IMPROVEMENT DUE TO MATURATION

Table KK1 Bilateral Skills

		Group A			Group B		
Category	School	Ass 1	Ass 2	Ass 3	Ass1	Ass 2	Ass 3
Name Writing	1	59	53	58	65	61	64
	2	55	51	58	54	53	58
	3	57	59	60	57	60	61
Drawing around an object	1	40	59	58	60	57	67
	2	45	63	65	52	60	60
	3	30	30	36	30	35	36
Tearing	1	23	35	37	21	21	38
	2	35	36	35	45	32	38
	3	17	29	29	22	17	28
Threading	1	54	60	62	53	57	62
	2	54	59	56	50	57	65
	3	48	49	51	47	49	50
Tying Shoelaces	1	22	41	51	24	55	54
	2	48	52	64	50	68	75
	3	57	58	63	43	57	57
Buttoning	1	84	86	90	82	86	84
	2	87	88	90	89	90	91
	3	83	84	88	85	86	85

This table shows the individual mean percentages of all bilateral skills tested in assessment 1, 2 and 3.

APPENDIX LL

PRACTICE SCORES

Table LL1 Mean percentages of the practice scores

		School 1		School 2		School 3	
	Number	Group A	Group B	Group A	Group B	Group A	Group B
Straight line	1	85	80	89	95	61	59
Wide zigzag	8	77	81	85	82	52	49
Square spiral	11	68	68	71	80	55	20
Narrow zigzag	12	69	80	75	70	54	40
Frog jumps	14	70	83	75	81	53	41
Wave	18	73	79	85	76	62	65
Straight line with bumps	22	68	70	75	73	47	59
Narrow waves	26	66	56	71	67	59	56
Upper and lower circles	28	68	72	80	65	52	42
Spiral	31	77	82	78	71	53	50
Circle	36	62	70	60	57	42	10
Lowest individual score		31	26	40	34	0	0
Highest individual Score		97	99	100	98	95	90

APPENDIX MM

PERCENTILE SCORES

The formula for computing the median is as follows:

$$Mdn = ll + \frac{(N)(50\%) - fc)\, i}{(fi)}$$

ll = exact lower limit of the interval containing the median

fc = sum of all the frequencies below this interval

fi = frequency in the interval containing the median

N = number of cases

i = size of interval

(60)

Practice Component

Table MM1 Percentile calculations for School 1A, Practice Component

Straight Line	School 1A			
	f	Cum f	Cum% f	Median
100	5	23	100	
90-99	10	18	78	93
80-89	2	8	35	
70-79	4	6	26	
60-69	1	2	9	
50-59	0	1	4	
40-49	0	1	4	
30-39	1	1	4	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM2 Percentile calculations for School 1B, Practice Component

Straight Line	School 1B			
	f	Cum f	Cum% f	Median
100	6	21	100	
90-99	3	15	71	
80-89	6	12	57	87
70-79	1	6	29	
60-69	2	5	24	
50-59	2	3	14	
40-49	1	1	5	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM3 Percentile calculations for School 2A, Practice Component

Straight Line	School 2A			
	f	Cum f	Cum% f	Median
100	10	20	100	
90-99	6	10	50	99.5
80-89	1	4	20	
70-79	1	3	15	
60-69	0	2	10	
50-59	2	2	10	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM4 Percentile calculations for School 2B, Practice Component

Straight Line	School 2B			
	f	Cum f	Cum% f	Median
100	15	23	100	100
90-99	6	8	35	
80-89	1	2	9	
70-79	0	1	4	
60-69	0	1	4	
50-59	1	1	4	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM5 Percentile calculations for School 3A, Practice Component

Straight Line	School 3A			
	f	Cum f	Cum% f	Median
100	4	29	100	
90-99	3	25	86	
80-89	5	22	76	
70-79	4	17	59	73.25
60-69	5	13	45	
50-59	0	8	28	
40-49	2	8	28	
30-39	1	6	21	
20-29	0	5	17	
10-19	1	5	17	
0-9	4	4	14	

Table MM6 Percentile calculations for School 3B, Practice Component

Straight Line	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	5	20	100	
80-89	4	15	75	
70-79	3	11	55	76.17
60-69	1	8	40	
50-59	1	7	35	
40-49	1	6	30	
30-39	0	5	25	
20-29	1	5	25	
10-19	2	4	20	
0-9	2	2	10	

Table MM7 Percentile calculations for School 1A, Practice Component

Wide zigzag	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	5	22	96	
80-89	8	17	74	82.63
70-79	4	9	39	
60-69	4	5	22	
50-59	0	1	4	
40-49	1	1	4	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM8 Percentile calculations for School 1B, Practice Component

Wide zigzag	School 1B			
	f	Cum f	Cum% f	Median
100	3	21	100	
90-99	7	18	86	
80-89	6	11	52	88.67
70-79	2	5	24	
60-69	1	3	14	
50-59	1	2	10	
40-49	0	1	5	
30-39	1	1	5	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM9 Percentile calculations for School 2A, Practice Component

Wide zigzag	School 2A			
	f	Cum f	Cum% f	Median
100	7	20	100	
90-99	5	13	65	93.5
80-89	4	8	40	
70-79	1	4	20	
60-69	2	3	15	
50-59	0	1	5	
40-49	0	1	5	
30-39	1	1	5	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM10 Percentile calculations for School 2B, Practice Component

Wide zigzag	School 2B			
	f	Cum f	Cum% f	Median
100	5	23	100	
90-99	7	18	78	90.21
80-89	5	11	48	
70-79	3	6	26	
60-69	1	3	13	
50-59	1	2	9	
40-49	1	1	4	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM11 Percentile calculations for School 3A, Practice Component

Wide zigzag	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	5	29	100	
80-89	3	24	83	
70-79	7	21	72	70.21
60-69	2	14	48	
50-59	3	12	41	
40-49	0	9	31	
30-39	1	9	31	
20-29	1	8	28	
10-19	1	7	24	
0-9	6	6	21	

Table MM12 Percentile calculations for School 3B, Practice Component

Wide zigzag	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	15	100	
80-89	4	14	93	
70-79	0	10	67	
60-69	1	10	67	
50-59	3	9	60	54.5
40-49	1	6	40	
30-39	1	5	33	
20-29	2	4	27	
10-19	0	2	13	
0-9	2	2	13	

Table MM13Percentile calculations for School 1A, Practice Component

Narrow zigzag	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	4	21	95	
80-89	4	17	77	
70-79	4	13	62	74.5
60-69	6	9	41	
50-59	1	3	14	
40-49	1	2	9	
30-39	0	1	5	
20-29	0	1	5	
10-19	1	1	5	
0-9	0	0	0	

Table MM14 Percentile calculations for School 1B, Practice Component

Narrow zigzag	School 1B			
	f	Cum f	Cum% f	Median
100	2	18	100	
90-99	6	16	89	
80-89	2	10	56	**84.5**
70-79	7	8	44	
60-69	0	1	6	
50-59	1	1	6	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM15 Percentile calculations for School 2A, Practice Component

Narrow zigzag	School 2A			
	f	Cum f	Cum% f	Median
100	5	18	100	
90-99	1	13	72	
80-89	4	12	67	**82**
70-79	4	8	44	
60-69	1	4	22	
50-59	0	3	17	
40-49	1	3	17	
30-39	2	2	11	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM16 Percentile calculations for School 2B, Practice Component

Narrow zigzag	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99	3	23	100	
80-89	8	20	87	
70-79	4	12	52	78.25
60-69	4	8	35	
50-59	2	4	17	
40-49	2	2	9	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM17 Percentile calculations for School 3A, Practice Component

Narrow zigzag	School 3A			
	f	Cum f	Cum% f	Median
100	1	28	100	
90-99	3	27	96	
80-89	6	24	86	
70-79	3	18	64	
60-69	4	15	54	67
50-59	2	11	39	
40-49	1	9	32	
30-39	1	8	29	
20-29	0	7	25	
10-19	3	7	25	
0-9	4	4	14	

Table MM18 Percentile calculations for School 3B, Practice Component

Narrow zigzag	School 3B			
	f	Cum f	Cum% f	Median
100	1	15	100	
90-99	1	14	93	
80-89	1	13	87	
70-79	2	12	80	
60-69	1	10	67	
50-59	1	9	60	
40-49	1	8	53	44.5
30-39	0	7	47	
20-29	1	7	47	
10-19	0	6	40	
0-9	6	6	40	

Table MM19 Percentile calculations for School 1A, Practice Component

Square Spiral	School 1A			
	f	Cum f	Cum% f	Median
100	2	22	100	
90-99	5	20	91	
80-89	4	15	68	
70-79	3	11	50	69.5
60-69	2	8	36	
50-59	0	6	27	
40-49	3	6	27	
30-39	0	3	14	
20-29	3	3	14	
10-19	0	0	0	
0-9	0	0	0	

Table MM20 Percentile calculations for School 1B, Practice Component

Square Spiral	School 1B			
	f	Cum f	Cum% f	Median
100	1	17	100	
90-99	5	16	94	
80-89	3	11	65	81.17
70-79	1	8	47	
60-69	2	7	41	
50-59	2	5	29	
40-49	1	3	18	
30-39	0	2	12	
20-29	1	2	12	
10-19	1	1	6	
0-9	0	0	0	

Table MM21 Percentile calculations for School 2A, Practice Component

Square Spiral	School 2A			
	f	Cum f	Cum% f	Median
100	4	16	100	
90-99	1	12	75	
80-89	0	11	69	
70-79	4	11	69	72
60-69	3	7	44	
50-59	2	4	25	
40-49	2	2	6	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM22 Percentile calculations for School 2B, Practice Component

Square Spiral	School 2B			
	f	Cum f	Cum% f	Median
100	8	22	100	
90-99	4	14	64	92
80-89	3	10	45	
70-79	1	7	32	
60-69	2	6	27	
50-59	1	4	18	
40-49	3	3	14	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM23 Percentile calculations for School 3A, Practice Component

Square Spiral	School 3A			
	f	Cum f	Cum% f	Median
100	1	11	100	
90-99	2	10	91	
80-89	1	8	73	
70-79	0	7	64	
60-69	4	7	64	65.75
50-59	0	3	27	
40-49	0	3	27	
30-39	0	3	27	
20-29	0	3	27	
10-19	0	3	27	
0-9	3	3	27	

Table MM24 Percentile calculations for School 3B, Practice Component

Square Spiral	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	4	100	
60-69	0	3	75	
50-59	0	3	75	
40-49	0	3	75	
30-39	0	3	75	
20-29	0	3	75	
10-19	1	3	75	
0-9	2	2	50	9.5

Table MM25 Percentile calculations for School 1A, Practice Component

Frog jumps	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	5	22	96	
80-89	5	17	74	
70-79	5	12	52	78.5
60-69	1	7	30	
50-59	3	6	26	
40-49	1	3	13	
30-39	0	2	9	
20-29	2	2	9	
10-19	0	0	0	
0-9	0	0	0	

Table MM26 Percentile calculations for School 1B, Practice Component

Frog jumps	School 1B			
	f	Cum f	Cum% f	Median
100	4	16	100	
90-99	3	12	75	
80-89	5	9	56	87.5
70-79	3	4	25	
60-69	0	1	6	
50-59	0	1	6	
40-49	1	1	6	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM27 Percentile calculations for School 2A, Practice Component

Frog jumps	School 2A			
	f	Cum f	Cum% f	Median
100	4	20	100	
90-99	3	16	80	
80-89	3	13	65	
70-79	3	10	50	79.5
60-69	4	7	35	
50-59	1	3	15	
40-49	2	2	10	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM28 Percentile calculations for School 2B, Practice Component

Frog jumps	School 2B			
	f	Cum f	Cum% f	Median
100	5	23	100	
90-99	7	18	78	90.21
80-89	4	11	48	
70-79	3	7	30	
60-69	3	4	17	
50-59	0	1	4	
40-49	0	1	4	
30-39	1	1	4	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM29 Percentile calculations for School 3A, Practice Component

Frog jumps	School 3A			
	f	Cum f	Cum% f	Median
100	1	27	100	
90-99	4	26	96	
80-89	6	22	81	
70-79	2	16	70	
60-69	0	14	52	
50-59	4	14	52	58.25
40-49	2	10	37	
30-39	1	8	30	
20-29	0	7	27	
10-19	2	7	26	
0-9	5	5	19	

Table MM30 Percentile calculations for School 3B, Practice Component

Frog jumps	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	4	14	100	
70-79	0	10	71	
60-69	1	10	71	
50-59	2	9	64	
40-49	1	7	50	49.5
30-39	1	6	43	
20-29	0	5	36	
10-19	2	5	36	
0-9	3	3	21	

Table MM31 Percentile calculations for School 1A, Practice Component

Wave	School 1A			
	f	Cum f	Cum% f	Median
100	3	23	100	
90-99	7	20	87	
80-89	3	13	57	84.5
70-79	3	10	43	
60-69	1	7	30	
50-59	1	6	26	
40-49	3	5	22	
30-39	0	2	9	
20-29	2	2	9	
10-19	0	0	0	
0-9	0	0	0	

Table MM32 Percentile calculations for School 1B, Practice Component

Wave	School 1B			
	f	Cum f	Cum% f	Median
100	3	18	100	
90-99	8	15	83	92
80-89	1	7	39	
70-79	3	6	33	
60-69	1	3	17	
50-59	1	2	11	
40-49	0	1	6	
30-39	0	1	6	
20-29	0	1	6	
10-19	1	1	6	
0-9	0	0	0	

Table MM33 Percentile calculations for School 2A, Practice Component

Wave	School 2A			
	f	Cum f	Cum% f	Median
100	6	20	100	
90-99	6	14	70	92.83
80-89	3	8	40	
70-79	3	5	25	
60-69	1	2	10	
50-59	0	1	5	
40-49	1	1	5	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM34 Percentile calculations for School 2B, Practice Component

Wave	School 2B			
	f	Cum f	Cum% f	Median
100	5	23	100	
90-99	7	18	78	90.21
80-89	2	11	48	
70-79	1	9	39	
60-69	4	8	35	
50-59	2	4	17	
40-49	0	2	9	
30-39	1	2	9	
20-29	0	1	4	
10-19	1	1	4	
0-9	0	0	0	

Table M35 Percentile calculations for School 3A, Practice Component

Wave	School 3A			
	f	Cum f	Cum% f	Median
100	1	28	100	
90-99	3	27	96	
80-89	6	24	86	
70-79	8	18	64	74.5
60-69	2	10	36	
50-59	1	8	29	
40-49	2	7	25	
30-39	2	5	18	
20-29	0	3	11	
10-19	2	3	11	
0-9	1	1	4	

Table MM36 Percentile calculations for School 3B, Practice Component

Wave	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	5	15	100	
80-89	3	10	67	81.17
70-79	2	7	47	
60-69	1	5	33	
50-59	0	4	27	
40-49	0	4	27	
30-39	2	4	27	
20-29	1	2	13	
10-19	0	1	7	
0-9	1	1	7	

Table MM37 Percentile calculations for School 1A, Practice Component

Straight line with bumps	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	5	21	95	
80-89	2	16	73	
70-79	6	14	64	74.5
60-69	1	8	36	
50-59	4	7	32	
40-49	1	3	14	
30-39	1	2	9	
20-29	1	1	5	
10-19	0	0	0	
0-9	0	0	0	

Table MM38 Percentile calculations for School 1B, Practice Component

Straight line with bumps	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	6	17	100	
80-89	2	11	65	
70-79	5	9	53	78.5
60-69	0	4	24	
50-59	1	4	24	
40-49	2	3	18	
30-39	0	1	6	
20-29	0	1	6	
10-19	1	1	6	
0-9	0	0	0	

Table MM39 Percentile calculations for School 2A, Practice Component

Straight line with bumps	School 2A			
	f	Cum f	Cum% f	Median
100	4	20	100	
90-99	5	16	80	
80-89	2	11	55	84.5
70-79	2	9	45	
60-69	3	7	35	
50-59	2	4	20	
40-49	1	2	10	
30-39	0	1	5	
20-29	1	1	5	
10-19	0	0	0	
0-9	0	0	0	

Table MM40 Percentile calculations for School 2B, Practice Component

Straight line with bumps	School 2B			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	6	21	91	
80-89	6	15	65	83.67
70-79	1	9	39	
60-69	3	8	35	
50-59	3	5	22	
40-49	1	2	9	
30-39	0	1	4	
20-29	1	1	4	
10-19	0	0	0	
0-9	0	0	0	

Table MM41 Percentile calculations for School 3A, Practice Component

Straight line with bumps	School 3A			
	f	Cum f	Cum% f	Median
100	1	26	100	
90-99	0	25	96	
80-89	6	25	96	
70-79	6	19	73	
60-69	1	13	50	69.5
50-59	1	12	46	
40-49	1	11	42	
30-39	2	10	38	
20-29	0	8	31	
10-19	1	8	31	
0-9	7	7	27	

Table MM42 Percentile calculations for School 3B, Practice Component

Straight line with bumps	School 3B			
	f	Cum f	Cum% f	Median
100	2	9	100	
90-99	0	7	78	
80-89	1	7	78	
70-79	1	6	67	
60-69	2	5	56	67
50-59	0	3	33	
40-49	0	3	33	
30-39	2	3	33	
20-29	0	1	11	
10-19	0	1	11	
0-9	1	1	11	

Table MM43 Percentile calculations for School 1A, Practice Component

Narrow Waves	School 1A			
	f	Cum f	Cum% f	Median
100	1	21	100	
90-99	4	20	95	
80-89	3	16	76	
70-79	4	13	62	73.25
60-69	4	9	43	
50-59	0	5	24	
40-49	2	5	24	
30-39	2	3	14	
20-29	1	1	5	
10-19	0	0	0	
0-9	0	0	0	

Table MM44 Percentile calculations for School 1B, Practice Component

Narrow Waves	School 1B			
	f	Cum f	Cum% f	Median
100	1	19	100	
90-99	2	18	95	
80-89	0	16	84	
70-79	4	16	84	
60-69	5	12	63	64.5
50-59	1	7	37	
40-49	2	6	32	
30-39	2	4	21	
20-29	0	2	11	
10-19	1	2	11	
0-9	1	1	5	

Table MM45 Percentile calculations for School 2A, Practice Component

Narrow Waves	School 2A			
	f	Cum f	Cum% f	Median
100	2	20	100	
90-99	7	18	90	
80-89	1	11	55	
70-79	1	10	50	79.5
60-69	3	9	45	
50-59	1	6	30	
40-49	4	5	25	
30-39	1	1	5	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM46 Percentile calculations for School 2B, Practice Component

Narrow Waves	School 2B			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	3	21	91	
80-89	5	18	78	
70-79	5	13	57	76.5
60-69	1	8	35	
50-59	2	7	30	
40-49	3	5	22	
30-39	1	2	9	
20-29	0	1	4	
10-19	1	1	4	
0-9	0	0	0	

Table MM47 Percentile calculations for School 3A, Practice Component

Narrow Waves	School 3A			
	f	Cum f	Cum% f	Median
100	1	26	100	
90-99	2	25	96	
80-89	7	23	88	
70-79	6	16	62	74.5
60-69	0	10	38	
50-59	1	10	38	
40-49	3	9	35	
30-39	3	6	23	
20-29	1	3	12	
10-19	0	2	8	
0-9	2	2	8	

Table MM48 Percentile calculations for School 3B, Practice Component

Narrow Waves	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	10	100	
80-89	1	9	90	
70-79	2	8	80	
60-69	0	6	60	
50-59	2	6	60	54.5
40-49	3	4	40	
30-39	1	1	10	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM49 Percentile calculations for School 1A, Practice Component

Upper and lower Circles	School 1A			
	f	Cum f	Cum% f	Median
100	3	22	100	
90-99	1	19	86	
80-89	6	18	82	
70-79	5	12	55	77.5
60-69	2	7	32	
50-59	0	5	23	
40-49	2	5	23	
30-39	1	3	14	
20-29	1	2	9	
10-19	1	1	5	
0-9	0	0	0	

Table MM50 Percentile calculations for School 1B, Practice Component

Upper + lower Circles	School 1B			
	f	Cum f	Cum% f	Median
100	3	18	100	
90-99	3	15	83	
80-89	4	12	67	**82**
70-79	3	8	44	
60-69	1	5	28	
50-59	2	4	22	
40-49	0	2	11	
30-39	1	2	11	
20-29	0	1	6	
10-19	1	1	6	
0-9	0	0	0	

Table MM51 Percentile calculations for School 2A, Practice Component

Upper + lower Circles	School 2A			
	f	Cum f	Cum% f	Median
100	4	20	100	
90-99	6	16	80	
80-89	2	10	50	89.5
70-79	3	8	40	
60-69	4	5	25	
50-59	1	1	5	
40-49	0	0	0	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM52 Percentile calculations for School 2B, Practice Component

Upper + lower Circles	School 2B			
	f	Cum f	Cum% f	Median
100	3	22	100	
90-99	1	19	86	
80-89	3	18	82	
70-79	3	15	68	
60-69	6	12	55	67.83
50-59	3	6	27	
40-49	2	3	14	
30-39	0	1	5	
20-29	0	1	5	
10-19	1	1	5	
0-9	0	0	0	

Table MM53 Percentile calculations for School 3A, Practice Component

Upper + lower Circles	School 3A			
	f	Cum f	Cum% f	Median
100	1	27	100	
90-99	3	26	96	
80-89	5	22	81	
70-79	3	17	63	
60-69	3	14	52	67.83
50-59	0	11	41	
40-49	4	11	41	
30-39	0	7	26	
20-29	1	7	26	
10-19	2	6	22	
0-9	4	4	15	

Table MM54 Percentile calculations for School 3B, Practice Component

Upper + lower Circles	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	9	100	
80-89	0	8	89	
70-79	0	8	89	
60-69	2	8	89	
50-59	2	6	67	52
40-49	0	4	44	
30-39	1	4	44	
20-29	1	3	33	
10-19	0	2	22	
0-9	2	2	22	

Table MM55 Percentile calculations for School 1A, Practice Component

Spiral	School 1A			
	f	Cum f	Cum% f	Median
100	7	22	100	
90-99	7	15	68	93.79
80-89	1	8	36	
70-79	2	7	32	
60-69	0	5	23	
50-59	0	5	23	
40-49	0	5	23	
30-39	1	5	23	
20-29	1	4	18	
10-19	0	3	14	
0-9	3	3	14	

Table MM56 Percentile calculations for School 1B, Practice Component

Spiral	School 1B			
	f	Cum f	Cum% f	Median
100	7	20	100	
90-99	3	13	65	
80-89	4	10	50	89.5
70-79	3	6	30	
60-69	1	3	15	
50-59	1	2	10	
40-49	1	1	5	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM57 Percentile calculations for School 2A, Practice Component

Spiral	School 2A			
	f	Cum f	Cum% f	Median
100	6	19	100	
90-99	4	13	84	90.75
80-89	4	9	47	
70-79	1	5	26	
60-69	1	4	21	
50-59	0	3	16	
40-49	1	3	16	
30-39	1	2	11	
20-29	0	1	5	
10-19	0	1	5	
0-9	1	1	5	

Table M58 Percentile calculations for School 2B, Practice Component

Spiral	School 2B			
	f	Cum f	Cum% f	Median
100	4	23	100	
90-99	7	19	83	
80-89	3	12	52	87.83
70-79	1	9	39	
60-69	2	8	35	
50-59	1	6	26	
40-49	2	5	22	
30-39	1	3	14	
20-29	0	2	9	
10-19	2	2	9	
0-9	0	0	0	

Table MM59 Percentile calculations for School 3A, Practice Component

Spiral	School 3A			
	f	Cum f	Cum% f	Median
100	5	25	100	
90-99	4	20	80	
80-89	1	16	64	
70-79	3	15	60	71.17
60-69	1	12	48	
50-59	1	11	44	
40-49	1	10	40	
30-39	0	9	36	
20-29	0	9	36	
10-19	2	9	36	
0-9	7	7	28	

Table MM60 Percentile calculations for School 3B, Practice Component

Spiral	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	11	100	
80-89	3	10	91	
70-79	2	7	64	72
60-69	0	5	45	
50-59	1	5	45	
40-49	0	4	36	
30-39	1	4	36	
20-29	0	3	27	
10-19	0	3	27	
0-9	3	3	27	

Table MM61 Percentile calculations for School 1A, Practice Component

Circle	School 1A			
	f	Cum f	Cum% f	Median
100	2	20	100	
90-99	4	18	90	
80-89	4	14	70	
70-79	0	10	50	
60-69	3	10	50	69.5
50-59	1	7	35	
40-49	0	6	30	
30-39	2	6	30	
20-29	2	4	20	
10-19	2	2	10	
0-9	0	0	0	

Table MM62 Percentile calculations for School 1B, Practice Component

Circle	School 1B			
	f	Cum f	Cum% f	Median
100	4	18	100	
90-99	2	14	78	
80-89	3	12	67	
70-79	2	9	50	79.5
60-69	2	7	39	
50-59	2	5	28	
40-49	2	3	17	
30-39	0	1	6	
20-29	0	1	6	
10-19	0	1	6	
0-9	1	1	6	

Table MM63 Percentile calculations for School 2A, Practice Component

Circle	School 2A			
	f	Cum f	Cum% f	Median
100	6	19	100	
90-99	2	13	68	
80-89	1	11	58	
70-79	1	10	53	74.5
60-69	2	9	47	
50-59	0	7	37	
40-49	1	7	37	
30-39	0	6	32	
20-29	2	6	32	
10-19	0	4	21	
0-9	4	4	21	

Table MM64 Percentile calculations for School 2B, Practice Component

Circle	School 2B			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	5	21	91	
80-89	2	16	70	
70-79	0	14	61	
60-69	2	14	61	
50-59	3	12	52	57.83
40-49	4	9	39	
30-39	0	5	22	
20-29	2	5	22	
10-19	2	3	13	
0-9	1	1	8	

Table MM65 Percentile calculations for School 3A, Practice Component

Circle	School 3A			
	f	Cum f	Cum% f	Median
100	2	21	100	
90-99	1	19	90	
80-89	1	18	86	
70-79	4	17	81	
60-69	1	13	62	
50-59	2	12	57	57
40-49	0	10	48	
30-39	1	10	48	
20-29	0	9	43	
10-19	5	9	43	
0-9	4	4	19	

Table MM66 Percentile calculations for School 3B, Practice Component

Circle	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49				
30-39				
20-29				
10-19				
0-9	1	1	100	4.5

PICTURE

Table MM67 Percentile calculations for School 1A, Picture Component

Flag	School 1A			
	f	Cum f	Cum% f	Median
100	8	22	100	
90-99	0	15	68	
80-89	8	15	68	79.55
70-79	0	7	32	
60-69	3	7	32	
50-59	3	4	18	
40-49	0	1	5	
30-39	1	1	5	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM68 Percentile calculations for School 1B, Picture Component

Flag	School 1B			
	f	Cum f	Cum% f	Median
100	5	21	100	
90-99	0	16	76	
80-89	5	16	76	
70-79	0	11	52	
60-69	5	11	52	68.5
50-59	2	6	29	
40-49	0	4	19	
30-39	1	4	19	
20-29	0	3	14	
10-19	2	3	14	
0-9	1	1	5	

Table MM69 Percentile calculations for School 2A, Picture Component

Flag	School 2A			
	f	Cum f	Cum% f	Median
100	6	23	100	
90-99	0	17	74	
80-89	6	17	74	80.33
70-79	0	11	48	
60-69	3	11	48	
50-59	2	8	35	
40-49	0	6	26	
30-39	0	6	26	
20-29	0	6	26	
10-19	4	6	26	
0-9	2	2	9	

Table MM70 Percentile calculations for School 2B, Picture Component

Flag	School 2B			
	f	Cum f	Cum% f	Median
100	10	23	100	
90-99	0	13	57	
80-89	4	13	57	85.75
70-79	0	9	39	
60-69	2	9	39	
50-59	2	7	30	
40-49	0	5	22	
30-39	3	5	22	
20-29	0	2	9	
10-19	1	2	9	
0-9	1	1	4	

Table MM71 Percentile calculations for School 3A, Picture Component

Flag	School 3A			
	f	Cum f	Cum% f	Median
100	1	37	100	
90-99	0	36	97	
80-89	2	36	97	
70-79	0	34	92	
60-69	6	34	92	
50-59	3	28	76	
40-49	0	25	68	
30-39	6	25	68	
20-29	0	19	51	
10-19	5	19	51	18.5
0-9	14	14	38	

Table MM72 Percentile calculations for School 3B, Picture Component

Flag	School 3B			
	f	Cum f	Cum% f	Median
100	1	15	100	
90-99	0	14	93	
80-89	1	14	93	
70-79	0	13	87	
60-69	1	13	87	
50-59	1	12	80	
40-49	0	11	73	
30-39	1	11	73	
20-29	0	10	67	
10-19	3	10	67	9.51667
0-9	7	7	47	

Table MM73 Percentile calculations for School 1A, Picture Component

Book	School 1A			
	F	Cum f	Cum% f	Median
100	6	23	100	
90-99	0	17	74	
80-89	4	17	74	
70-79	0	13	57	
60-69	6	13	57	67
50-59	2	7	30	
40-49	0	5	22	
30-39	2	5	22	
20-29	0	3	13	
10-19	3	3	13	
0-9	0	0	0	

Table MM74 Percentile calculations for School 1B, Picture Component

Book	School 1B			
	f	Cum f	Cum% f	Median
100	8	21	100	
90-99	0	13	62	
80-89	5	13	62	84.5
70-79	0	8	38	
60-69	4	8	38	
50-59	2	4	19	
40-49	0	2	10	
30-39	1	2	10	
20-29	0	1	5	
10-19	1	1	5	
0-9	0	0	0	

Table MM75 Percentile calculations for School 2A, Picture Component

Book	School 2A			
	F	Cum f	Cum% f	Median
100	11	23	100	
90-99	0	12	52	
80-89	1	12	52	84.5
70-79	0	11	48	
60-69	0	11	48	
50-59	1	11	48	
40-49	0	10	43	
30-39	1	10	43	
20-29	0	9	39	
10-19	4	9	39	
0-9	5	5	22	

Table MM76 Percentile calculations for School 2B, Picture Component

Book	School 2B			
	f	Cum f	Cum% f	Median
100	10	23	100	
90-99	0	13	57	
80-89	3	13	57	84.5
70-79	0	10	43	
60-69	3	10	43	
50-59	3	7	30	
40-49	0	4	17	
30-39	3	4	17	
20-29	0	1	4	
10-19	0	1	4	
0-9	1	1	4	

Table MM77 Percentile calculations for School 3A, Picture Component

Book	School 3A			
	f	Cum f	Cum% f	Median
100	1	37	100	
90-99	0	36	97	
80-89	3	36	97	
70-79	0	33	89	
60-69	3	33	89	
50-59	4	30	81	
40-49	0	26	70	
30-39	5	26	70	
20-29	0	21	57	
10-19	4	21	57	13.25
0-9	17	17	46	

Table MM78 Percentile calculations for School 3B, Picture Component

Book	School 3B			
	f	Cum f	Cum% f	Median
100	2	15	100	
90-99	0	13	87	
80-89	0	13	87	
70-79	0	13	87	
60-69	1	13	87	
50-59	0	12	80	
40-49	0	12	80	
30-39	1	12	80	
20-29	0	11	73	
10-19	2	11	73	
0-9	9	9	60	7.83

Table MM79 Percentile calculations for School 1A, Picture Component

House	School 1A			
	f	Cum f	Cum% f	Median
100	6	23	100	
90-99	0	17	74	
80-89	5	17	74	
70-79	4	12	52	78.25
60-69	0	8	35	
50-59	4	8	35	
40-49	2	4	17	
30-39	0	2	9	
20-29	1	2	9	
10-19	1	1	4	
0-9	0	0	0	

Table MM80 Percentile calculations for School 1B, Picture Component

House	School 1B			
	f	Cum f	Cum% f	Median
100	7	20	100	
90-99	0	13	65	
80-89	5	13	65	83.5
70-79	2	8	40	
60-69	0	6	30	
50-59	3	6	30	
40-49	3	3	15	
30-39	0	0	0	
20-29	0	0	0	
10-19	0	0	0	
0-9	0	0	0	

Table MM81 Percentile calculations for School 2A, Picture Component

House	School 2A			
	f	Cum f	Cum% f	Median
100	6	23	100	
90-99	0	17	74	
80-89	5	17	74	
70-79	2	12	52	77
60-69	0	10	43	
50-59	4	10	43	
40-49	2	6	26	
30-39	0	4	17	
20-29	1	4	17	
10-19	1	3	13	
0-9	2	2	9	

Table MM82 Percentile calculations for School 2B, Picture Component

House	School 2B			
	f	Cum f	Cum% f	Median
100	7	23	100	
90-99	0	16	70	
80-89	4	16	70	
70-79	5	12	52	78.5
60-69	0	7	30	
50-59	4	7	30	
40-49	1	3	13	
30-39	0	2	9	
20-29	1	2	9	
10-19	0	1	4	
0-9	1	1	4	

Table MM83 Percentile calculations for School 3A, Picture Component

House	School 3A			
	f	Cum f	Cum% f	Median
100	2	37	100	
90-99	0	35	95	
80-89	4	35	95	
70-79	2	31	84	
60-69	0	29	78	
50-59	4	29	78	
40-49	4	25	68	
30-39	0	21	57	
20-29	4	21	57	23.25
10-19	5	17	46	
0-9	12	12	32	

Table MM84 Percentile calculations for School 3B, Picture Component

House	School 3B			
	f	Cum f	Cum% f	Median
100	1	15	100	
90-99	0	14	93	
80-89	0	14	93	
70-79	0	14	93	
60-69	0	14	93	
50-59	1	14	93	
40-49	1	13	87	
30-39	0	12	80	
20-29	1	12	80	
10-19	4	11	73	10.75
0-9	7	7	47	

Table MM85 Percentile calculations for School 1A, Picture Component

Boat	School 1A			
	f	Cum f	Cum% f	Median
100	4	23	100	
90-99	2	19	83	
80-89	5	17	74	
70-79	2	12	52	77
60-69	5	10	43	
50-59	1	5	22	
40-49	2	4	17	
30-39	1	2	9	
20-29	1	1	4	
10-19	0	0	0	
0-9	0	0	0	

Table MM86 Percentile calculations for School 1B, Picture Component

Boat	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	2	19	90	
70-79	5	17	85	
60-69	2	12	60	
50-59	3	10	50	59.5
40-49	3	7	35	
30-39	0	4	20	
20-29	3	4	20	
10-19	1	1	5	
0-9	0	0	0	

Table MM87 Percentile calculations for School 2A, Picture Component

Boat	School 2A			
	f	Cum f	Cum% f	Median
100	5	23	100	
90-99	2	18	78	
80-89	3	16	70	
70-79	5	13	57	76.5
60-69	2	8	35	
50-59	0	6	26	
40-49	2	6	26	
30-39	0	4	17	
20-29	3	4	17	
10-19	1	1	4	
0-9	0	0	0	

Table MM88 Percentile calculations for School 2B, Picture Component

Boat	School 2B			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	3	22	96	
80-89	3	19	83	
70-79	3	16	70	
60-69	0	13	57	
50-59	7	13	57	57.357
40-49	2	6	26	
30-39	2	4	17	
20-29	2	2	9	
10-19	0	0	0	
0-9	0	0	0	

Table MM89 Percentile calculations for School 3A, Picture Component

Boat	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	37	100	
70-79	4	35	95	
60-69	0	31	84	
50-59	5	31	84	
40-49	4	26	70	
30-39	0	22	59	
20-29	2	22	59	
10-19	9	20	54	17.83
0-9	11	11	30	

Table MM90 Percentile calculations for School 3B, Picture Component

Boat	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	15	100	
70-79	0	14	93	
60-69	0	14	93	
50-59	2	14	93	
40-49	0	12	80	
30-39	2	12	80	
20-29	0	10	67	
10-19	1	10	67	
0-9	9	9	60	7.83

Table MM91 Percentile calculations for School 1A, Picture Component

Tree	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	1	23	100	
80-89	2	22	96	
70-79	4	20	87	
60-69	5	16	70	60.5
50-59	4	11	48	
40-49	2	7	30	
30-39	1	5	22	
20-29	1	4	17	
10-19	2	3	13	
0-9	1	1	4	

Table MM92 Percentile calculations for School 1B, Picture Component

Tree	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	0	19	95	
70-79	0	19	95	
60-69	3	19	95	
50-59	8	16	80	52
40-49	4	8	40	
30-39	2	4	20	
20-29	0	2	10	
10-19	1	2	10	
0-9	1	1	5	

Table MM93 Percentile calculations for School 2A, Picture Component

Tree	School 2A			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	0	21	91	
80-89	1	21	91	
70-79	3	20	87	
60-69	4	17	74	
50-59	3	13	57	54.5
40-49	4	10	43	
30-39	3	6	26	
20-29	1	3	13	
10-19	1	2	9	
0-9	1	1	4	

Table MM94 Percentile calculations for School 2B, Picture Component

Tree	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	2	21	95	
70-79	5	19	86	
60-69	5	14	64	63.5
50-59	2	9	41	
40-49	4	7	32	
30-39	0	3	14	
20-29	2	3	14	
10-19	0	1	5	
0-9	1	1	5	

Table MM95 Percentile calculations for School 3A, Picture Component

Tree	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	35	100	
70-79	3	34	97	
60-69	4	31	89	
50-59	1	27	77	
40-49	5	26	74	
30-39	3	21	60	
20-29	1	18	51	24.5
10-19	4	17	49	
0-9	13	13	37	

Table MM96 Percentile calculations for School 3B, Picture Component

Tree	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	14	100	
80-89	0	13	93	
70-79	1	13	93	
60-69	0	12	86	
50-59	0	12	86	
40-49	0	12	86	
30-39	2	12	86	
20-29	1	10	71	
10-19	0	9	64	
0-9	9	9	64	7.277

Table MM97 Percentile calculations for School 1A, Picture Component

Fence	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	2	23	100	
80-89	5	21	91	
70-79	1	16	70	
60-69	4	15	65	60.75
50-59	2	11	48	
40-49	3	9	39	
30-39	3	6	26	
20-29	2	3	13	
10-19	1	1	4	
0-9	0	0	0	

Table MM98 Percentile calculations for School 1B, Picture Component

Fence	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	19	100	
80-89	1	18	95	
70-79	2	17	89	
60-69	3	15	79	
50-59	6	12	63	55.33
40-49	2	6	32	
30-39	1	4	21	
20-29	1	3	16	
10-19	2	2	11	
0-9	0	0	0	

Table MM99 Percentile calculations for School 2A, Picture Component

Fence	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	2	23	100	
80-89	1	21	91	
70-79	6	20	87	
60-69	5	14	61	64.5
50-59	2	9	39	
40-49	1	7	30	
30-39	2	6	26	
20-29	1	4	17	
10-19	2	3	13	
0-9	1	1	4	

Table MM100 Percentile calculations for School 2B, Picture Component

Fence	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	0	21	95	
70-79	6	21	95	
60-69	0	15	68	
50-59	6	15	68	52.83
40-49	5	9	41	
30-39	2	4	18	
20-29	1	2	9	
10-19	0	1	5	
0-9	1	1	5	

Table MM101 Percentile calculations for School 3A, Picture Component

Fence	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	35	100	
70-79	3	34	97	
60-69	6	31	89	
50-59	3	25	71	
40-49	2	22	63	
30-39	3	20	57	31.16
20-29	4	17	49	
10-19	3	13	37	
0-9	10	10	29	

Table MM102 Percentile calculations for School 3B, Picture Component

Fence	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	14	100	
80-89	0	13	93	
70-79	0	13	93	
60-69	1	13	93	
50-59	0	12	86	
40-49	0	12	86	
30-39	3	12	86	
20-29	3	9	64	22.83
10-19	0	6	43	
0-9	6	6	43	

Table MM103 Percentile calculations for School 1A, Picture Component

Sun	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	2	23	100	
80-89	0	21	91	
70-79	3	21	91	
60-69	2	18	78	
50-59	4	16	70	
40-49	2	12	52	47
30-39	5	10	43	
20-29	2	5	22	
10-19	1	3	13	
0-9	2	2	9	

Table MM104 Percentile calculations for School 1B, Picture Component

Sun	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	21	100	
70-79	0	20	95	
60-69	2	20	95	
50-59	1	18	86	
40-49	4	17	81	
30-39	4	13	62	33.25
20-29	5	9	43	
10-19	2	4	19	
0-9	2	2	10	

Table MM105 Percentile calculations for School 2A, Picture Component

Sun	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	23	100	
70-79	4	22	96	
60-69	1	18	78	
50-59	3	17	74	
40-49	5	14	61	44.5
30-39	2	9	39	
20-29	3	7	30	
10-19	1	4	17	
0-9	3	3	13	

Table MM106 Percentile calculations for School 2B, Picture Component

Sun	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	2	23	100	
60-69	3	21	91	
50-59	1	18	78	
40-49	3	17	74	
30-39	7	14	61	35.93
20-29	5	7	30	
10-19	2	2	9	
0-9	0	0	0	

Table MM107 Percentile calculations for School 3A, Picture Component

Sun	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	33	100	
70-79	0	31	94	
60-69	1	31	94	
50-59	0	30	91	
40-49	2	30	91	
30-39	6	28	85	
20-29	6	22	67	20.33
10-19	5	16	48	
0-9	11	11	33	

Table MM108 Percentile calculations for School 3B, Picture Component

Sun	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	15	100	
70-79	1	14	93	
60-69	0	13	87	
50-59	0	13	87	
40-49	1	13	87	
30-39	1	12	80	
20-29	4	11	73	20.75
10-19	3	7	47	
0-9	4	4	27	

Table MM109 Percentile calculations for School 1A, Picture Component

Castle	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	23	100	
70-79	4	22	96	
60-69	4	18	78	
50-59	0	14	61	
40-49	3	14	61	41.167
30-39	6	11	48	
20-29	4	5	22	
10-19	0	1	4	
0-9	1	1	4	

Table MM110 Percentile calculations for School 1B, Picture Component

Castle	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	17	100	
70-79	2	16	94	
60-69	3	14	82	
50-59	1	11	65	
40-49	3	10	59	44.5
30-39	2	7	41	
20-29	3	5	29	
10-19	1	2	12	
0-9	1	1	6	

Table MM111 Percentile calculations for School 2A, Picture Component

Castle	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	2	22	100	
80-89	2	20	91	
70-79	5	18	82	
60-69	3	13	59	62.83
50-59	0	10	45	
40-49	2	10	45	
30-39	3	8	36	
20-29	3	5	23	
10-19	2	2	9	
0-9	0	0	0	

Table MM112 Percentile calculations for School 2B, Picture Component

Castle	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	2	22	100	
60-69	5	20	91	
50-59	3	15	68	
40-49	2	12	55	44.5
30-39	5	10	45	
20-29	3	5	23	
10-19	1	2	9	
0-9	1	1	4	

Table MM113 Percentile calculations for School 3A, Picture Component

Castle	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	34	100	
60-69	4	33	97	
50-59	2	29	85	
40-49	2	27	79	
30-39	5	25	74	
20-29	4	20	54	22
10-19	3	16	47	
0-9	13	13	38	

Table MM114 Percentile calculations for School 3B, Picture Component

Castle	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	14	100	
70-79	0	13	93	
60-69	1	13	93	
50-59	0	12	86	
40-49	1	12	86	
30-39	1	11	79	
20-29	3	10	71	
10-19	1	7	50	19.5
0-9	6	6	43	

Table MM115 Percentile calculations for School 1A, Picture Component

Balloon	School 1A			
	f	Cum f	Cum% f	Median
100	3	23	100	
90-99	0	20	87	
80-89	0	20	87	
70-79	1	20	87	
60-69	2	19	83	
50-59	1	17	74	
40-49	0	16	70	
30-39	5	16	70	30.5
20-29	5	11	48	
10-19	4	6	26	
0-9	2	2	9	

Table MM116 Percentile calculations for School 1B, Picture Component

Balloon	School 1B			
	f	Cum f	Cum% f	Median
100	2	18		
90-99				
80-89				
70-79	1	16		
60-69	2	15		
50-59	1	13		
40-49				
30-39	1	12		
20-29	7	11		26.64
10-19	3	4		
0-9	1	1		

Table MM117 Percentile calculations for School 2A, Picture Component

Balloon	School 2A			
	f	Cum f	Cum% f	Median
100	1	21	100	
90-99	0	20	95	
80-89	1	20	95	
70-79	0	19	90	
60-69	2	19	90	
50-59	3	17	81	
40-49	0	14	67	
30-39	2	14	67	
20-29	6	12	57	27
10-19	5	6	29	
0-9	1	1	5	

Table MM118 Percentile calculations for School 2B, Picture Component

Balloon	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	22	100	
70-79	2	21	95	
60-69	1	19	86	
50-59	4	18	82	
40-49	0	14	64	
30-39	2	14	64	
20-29	7	12	55	28.07
10-19	5	5	23	
0-9	0	0	0	

Table MM119 Percentile calculations for School 3A, Picture Component

Balloon	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	31	100	
70-79	0	29	94	
60-69	1	29	94	
50-59	4	28	90	
40-49	0	24	77	
30-39	7	24	77	
20-29	1	17	55	
10-19	6	16	52	18.67
0-9	10	10	32	

Table MM120 Percentile calculations for School 3B, Picture Component

Balloon	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	11	100	
50-59	2	10	91	
40-49	0	8	73	
30-39	1	8	73	
20-29	2	7	64	22
10-19	1	5	45	
0-9	4	4	36	

Table MM121 Percentile calculations for School 1A, Picture Component

Owl	School 1A			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	0	21	91	
80-89	1	21	91	
70-79	2	20	87	
60-69	0	18	78	
50-59	5	18	78	
40-49	1	13	57	
30-39	2	12	52	37
20-29	8	10	43	
10-19	1	2	9	
0-9	1	1	4	

Table MM122 Percentile calculations for School 1B, Picture Component

Owl	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	18	100	
60-69	2	17	94	
50-59	1	15	83	
40-49	2	14	78	
30-39	2	12	67	
20-29	4	10	56	37
10-19	1	6	33	
0-9	5	5	28	

Table MM123 Percentile calculations for School 2A, Picture Component

Owl	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	1	21	95	
70-79	2	20	91	
60-69	0	18	82	
50-59	0	18	82	
40-49	0	18	82	
30-39	3	18	82	
20-29	9	15	68	25.06
10-19	2	6	27	
0-9	4	4	18	

Table MM124 Percentile calculations for School 2B, Picture Component

Owl	School 2B			
	f	Cum f	Cum% f	Median
100	0	23	100	
90-99	0	23	100	
80-89	0	23	100	
70-79	2	23	100	
60-69	0	21	91	
50-59	5	21	91	
40-49	0	16	70	
30-39	0	16	70	
20-29	7	16	70	23.07
10-19	3	9	39	
0-9	6	6	26	

Table MM125 Percentile calculations for School 3A, Picture Component

Owl	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	30	100	
80-89	0	29	97	
70-79	0	29	97	
60-69	1	29	97	
50-59	3	28	93	
40-49	2	25	83	
30-39	1	23	77	
20-29	4	22	73	
10-19	4	18	60	12
0-9	14	14	47	

Table MM126 Percentile calculations for School 3B, Picture Component

Owl	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	12	100	
40-49	0	11	92	
30-39	2	11	92	
20-29	0	9	75	
10-19	1	9	75	
0-9	8	8	67	7

Table MM127 Percentile calculations for School 1A, Picture Component

Kite	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	1	22	96	
80-89	1	21	91	
70-79	2	20	87	
60-69	3	18	78	
50-59	4	15	65	50.75
40-49	2	11	48	
30-39	3	9	39	
20-29	4	6	26	
10-19	2	2	9	
0-9	0	0	0	

Table MM128 Percentile calculations for School 1B, Picture Component

Kite	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	19	100	
70-79	1	17	89	
60-69	1	16	84	
50-59	5	15	79	
40-49	1	10	53	44.5
30-39	6	9	47	
20-29	3	3	16	
10-19	0	0	0	
0-9	0	0	0	

Table MM129 Percentile calculations for School 2A, Picture Component

Kite	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	4	19	100	
60-69	3	15	79	
50-59	0	12	63	
40-49	4	12	63	43.25
30-39	3	8	42	
20-29	3	5	26	
10-19	2	2	11	
0-9	0	0	0	

Table MM130 Percentile calculations for School 2B, Picture Component

Kite	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	23	100	
70-79	2	21	91	
60-69	1	19	83	
50-59	3	18	78	
40-49	5	15	65	42.5
30-39	5	10	43	
20-29	2	5	22	
10-19	1	3	13	
0-9	2	2	9	

Table MM131 Percentile calculations for School 3A, Picture Component

Kite	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	29	100	
80-89	2	28	97	
70-79	2	26	90	
60-69	1	24	83	
50-59	2	23	79	
40-49	0	21	72	
30-39	4	21	72	
20-29	5	17	59	24.5
10-19	1	12	41	
0-9	11	11	38	

Table MM132 Percentile calculations for School 3B, Picture Component

Kite	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99	1	11	100	
80-89	0	10	91	
70-79	0	10	91	
60-69	0	10	91	
50-59	1	10	91	
40-49	1	9	82	
30-39	0	8	73	
20-29	3	8	73	21.17
10-19	1	5	45	
0-9	4	4	36	

Table MM133 Percentile calculations for School 1A, Picture Component

Car	School 1A			
	f	Cum f	Cum% f	Median
100	0	23	100	
90-99	1	23	100	
80-89	2	22	96	
70-79	0	20	87	
60-69	1	20	87	
50-59	1	19	83	
40-49	2	18	78	
30-39	3	16	70	
20-29	1	13	57	
10-19	2	12	52	17
0-9	10	10	43	

Table MM134 Percentile calculations for School 1B, Picture Component

Car	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	16	100	
70-79	0	15	94	
60-69	0	15	94	
50-59	1	15	94	
40-49	2	14	87	
30-39	2	12	75	
20-29	1	10	62	
10-19	3	9	56	16.17
0-9	6	6	37	

Table MM135 Percentile calculations for School 2A, Picture Component

Car	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	22	100	
70-79	0	20	91	
60-69	1	20	91	
50-59	0	19	86	
40-49	2	19	86	
30-39	1	17	77	
20-29	4	16	73	
10-19	5	12	55	17.5
0-9	7	7	32	

Table MM136 Percentile calculations for School 2B, Picture Component

Car	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	3	22	100	
40-49	3	19	86	
30-39	5	16	73	
20-29	1	11	50	29.5
10-19	5	10	45	
0-9	5	5	23	

Table MM137 Percentile calculations for School 3A, Picture Component

Car	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	32	100	
50-59	0	31	97	
40-49	1	31	97	
30-39	3	30	94	
20-29	2	27	84	
10-19	4	25	78	
0-9	21	21	66	7.119

Table MM138 Percentile calculations for School 3B, Picture Component

Car	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	12	100	
40-49	0	11	92	
30-39	1	11	92	
20-29	0	10	83	
10-19	2	10	83	
0-9	8	8	67	7

Table MM139 Percentile calculations for School 1A, Picture Component

Flower	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	1	22	96	
80-89	0	21	91	
70-79	0	21	91	
60-69	2	21	91	
50-59	2	19	83	
40-49	3	17	74	
30-39	2	14	61	
20-29	3	12	52	27.83
10-19	3	9	39	
0-9	6	6	26	

Table MM140 Percentile calculations for School 1B, Picture Component

Flower	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	16	100	
50-59	1	15	94	
40-49	1	14	87	
30-39	2	13	81	
20-29	1	11	69	
10-19	2	10	62	
0-9	8	8	50	9.5

Table MM141 Percentile calculations for School 2A, Picture Component

Flower	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	2	17	100	
80-89	0	15	88	
70-79	1	15	88	
60-69	2	14	82	
50-59	1	12	71	
40-49	2	11	65	
30-39	1	9	53	34.5
20-29	0	8	47	
10-19	2	8	47	
0-9	6	6	35	

Table MM142 Percentile calculations for School 2B, Picture Component

Flower	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	22	100	
60-69	0	21	95	
50-59	0	21	95	
40-49	4	21	95	
30-39	0	17	77	
20-29	3	17	77	
10-19	4	14	64	12
0-9	10	10	45	

Table MM143 Percentile calculations for School 3A, Picture Component

Flower	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	34	100	
80-89	0	33	97	
70-79	0	33	97	
60-69	0	33	97	
50-59	1	33	97	
40-49	3	32	94	
30-39	1	29	85	
20-29	3	28	82	
10-19	2	25	74	
0-9	23	23	70	6.89

Table MM144 Percentile calculations for School 3B, Picture Component

Flower	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49	1	14	100	
30-39	1	13	93	
20-29	2	12	86	
10-19	0	10	71	
0-9	10	10	71	6.5

Table MM145 Percentile calculations for School 1A, Picture Component

Hippo	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	1	22	96	
80-89	1	21	91	
70-79	1	20	87	
60-69	4	19	83	
50-59	1	15	65	
40-49	1	14	61	
30-39	3	13	57	34.5
20-29	1	10	43	
10-19	0	9	39	
0-9	9	9	39	

Table MM146 Percentile calculations for School 1B, Picture Component

Hippo	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	4	18	100	
50-59	1	14	78	
40-49	0	13	72	
30-39	1	13	72	
20-29	4	12	67	22
10-19	3	8	44	
0-9	5	5	28	

Table MM147 Percentile calculations for School 2A, Picture Component

Hippo	School 2A			
	f	Cum f	Cum% f	Median
100	3	22	100	
90-99	0	19	86	
80-89	0	19	86	
70-79	0	19	86	
60-69	3	19	86	
50-59	0	16	73	
40-49	2	16	73	
30-39	2	14	64	
20-29	3	12	55	26.17
10-19	3	9	41	
0-9	6	6	27	

Table MM148 Percentile calculations for School 2B, Picture Component

Hippo	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	22	100	
60-69	0	21	95	
50-59	2	21	95	
40-49	2	19	86	
30-39	5	17	77	
20-29	2	12	55	24.5
10-19	4	10	45	
0-9	6	6	27	

Table MM149 Percentile calculations for School 3A, Picture Component

Hippo	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49	1	30	100	
30-39	4	29	97	
20-29	3	25	83	
10-19	2	22	73	
0-9	20	20	67	7

Table MM150 Percentile calculations for School 3B, Picture Component

Hippo	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	12	100	
50-59	0	11	92	
40-49	1	11	92	
30-39	0	10	83	
20-29	1	10	83	
10-19	2	9	75	
0-9	7	7	58	8.07

Table MM151 Percentile calculations for School 1A, Picture Component

Tortoise	School 1A			
	f	Cum f	Cum% f	Median
100	3	23	100	
90-99	0	20	87	
80-89	2	20	87	
70-79	2	18	78	
60-69	0	16	70	
50-59	4	16	70	
40-49	0	12	52	
30-39	0	12	52	
20-29	3	12	52	27.83
10-19	2	9	39	
0-9	7	7	30	

Table MM152 Percentile calculations for School 1B, Picture Component

Tortoise	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	18	100	
70-79	1	17	94	
60-69	0	16	89	
50-59	0	16	89	
40-49	2	16	89	
30-39	0	14	78	
20-29	3	14	78	
10-19	7	11	61	16.64
0-9	4	4	22	

Table MM153 Percentile calculations for School 2A, Picture Component

Tortoise	School 2A			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	0	21	91	
80-89	1	21	91	
70-79	0	20	87	
60-69	0	20	87	
50-59	2	20	87	
40-49	2	18	78	
30-39	0	16	70	
20-29	5	16	70	20.5
10-19	6	11	48	
0-9	5	5	22	

Table MM154 Percentile calculations for School 2B, Picture Component

Tortoise	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	3	20	100	
40-49	1	17	85	
30-39	0	16	80	
20-29	5	16	80	
10-19	5	11	55	17.5
0-9	6	6	30	

Table MM155 Percentile calculations for School 3A, Picture Component

Tortoise	School 3A			
	f	Cum f	Cum% f	Median
100	1	30	100	
90-99	0	29	97	
80-89	0	29	97	
70-79	1	29	97	
60-69	0	28	93	
50-59	2	28	93	
40-49	3	26	87	
30-39	0	23	77	
20-29	1	23	77	
10-19	4	22	73	
0-9	18	18	60	7.83

Table MM156 Percentile calculations for School 3B, Picture Component

Tortoise	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	2	12	100	
40-49	0	10	83	
30-39	0	10	83	
20-29	2	10	83	
10-19	1	8	67	
0-9	7	7	58	8.07

Table MM157 Percentile calculations for School 1A, Picture Component

Tree	School 1A			
	f	Cum f	Cum% f	Median
100	2	22	100	
90-99	0	20	91	
80-89	2	20	91	
70-79	3	18	82	
60-69	0	15	68	
50-59	1	15	68	
40-49	4	14	64	42
30-39	0	10	45	
20-29	4	10	45	
10-19	1	6	27	
0-9	5	5	23	

Table MM158 Percentile calculations for School 1B, Picture Component

Tree	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	17	100	
40-49	3	16	94	
30-39	0	13	76	
20-29	3	13	76	
10-19	5	10	59	16.5
0-9	5	5	29	

Table MM159 Percentile calculations for School 2A, Picture Component

Tree	School 2A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	0	22	96	
80-89	2	22	96	
70-79	1	20	87	
60-69	0	19	83	
50-59	3	19	83	
40-49	1	16	70	
30-39	0	15	65	
20-29	7	15	65	24.5
10-19	2	8	35	
0-9	6	6	26	

Table MM160 Percentile calculations for School 2B, Picture Component

Tree	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49	4	21	100	
30-39	0	17	81	
20-29	2	17	81	
10-19	10	15	71	15
0-9	5	5	24	

Table MM161 Percentile calculations for School 3A, Picture Component

Tree	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	22	100	
60-69	0	21	95	
50-59	4	21	95	
40-49	0	17	77	
30-39	0	17	77	
20-29	1	17	77	
10-19	2	16	73	
0-9	14	14	64	7.36

Table MM162 Percentile calculations for School 3B, Picture Component

Tree	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	16	100	
40-49	0	15	94	
30-39	0	15	94	
20-29	3	15	94	
10-19	2	12	75	
0-9	10	10	62	7.5

Table MM163 Percentile calculations for School 1A, Picture Component

Elephant	School 1A			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	1	21	91	
80-89	0	20	87	
70-79	1	20	87	
60-69	1	19	83	
50-59	2	18	78	
40-49	2	16	70	
30-39	3	14	61	31.17
20-29	2	11	48	
10-19	1	9	39	
0-9	8	8	35	

Table MM164 Percentile calculations for School 1B, Picture Component

Elephant	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	19	100	
70-79	0	18	95	
60-69	1	18	95	
50-59	1	17	89	
40-49	3	16	84	
30-39	1	13	68	
20-29	2	12	63	
10-19	6	10	53	18.67
0-9	4	4	21	

Table MM165 Percentile calculations for School 2A, Picture Component

Elephant	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	22	100	
70-79	2	21	95	
60-69	2	19	86	
50-59	2	17	77	
40-49	1	15	68	
30-39	1	14	64	
20-29	1	13	59	
10-19	6	12	55	17.83
0-9	6	6	27	

Table MM166 Percentile calculations for School 2B, Picture Component

Elephant	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	23	100	
50-59	3	22	96	
40-49	1	19	83	
30-39	4	18	78	
20-29	7	14	61	25.93
10-19	3	7	30	
0-9	4	4	17	

Table MM167 Percentile calculations for School 3A, Picture Component

Elephant	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	18	100	
80-89	0	17	94	
70-79	1	17	94	
60-69	2	16	89	
50-59	2	14	78	
40-49	0	12	67	
30-39	1	12	67	
20-29	0	11	61	
10-19	2	11	61	
0-9	9	9	50	9.5

Table MM168 Percentile calculations for School 3B, Picture Component

Elephant	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	2	13	100	
50-59	0	11	85	
40-49	0	11	85	
30-39	2	11	85	
20-29	2	9	69	
10-19	2	7	54	17
0-9	5	5	38	

Table MM169 Percentile calculations for School 1A, Picture Component

Bird	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	2	22	100	
80-89	2	20	91	
70-79	2	18	82	
60-69	1	16	73	
50-59	4	15	68	
40-49	1	11	50	49.5
30-39	0	10	45	
20-29	3	10	45	
10-19	4	7	32	
0-9	3	3	14	

Table MM170 Percentile calculations for School 1B, Picture Component

Bird	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	17	100	
50-59	2	16	94	
40-49	2	14	82	
30-39	2	12	71	
20-29	2	10	59	22
10-19	6	8	47	
0-9	2	2	12	

Table MM171 Percentile calculations for School 2A, Picture Component

Bird	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	0	19	95	
70-79	1	19	95	
60-69	1	18	90	
50-59	2	17	85	
40-49	1	15	75	
30-39	2	14	70	
20-29	4	12	60	24.5
10-19	7	8	40	
0-9	1	1	5	

Table MM172 Percentile calculations for School 2B, Picture Component

Bird	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	22	100	
40-49	2	21	95	
30-39	6	19	86	
20-29	5	13	59	25.5
10-19	6	8	36	
0-9	2	2	9	

Table MM173 Percentile calculations for School 3A, Picture Component

Bird	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	7	100	
50-59	0	6	86	
40-49	1	6	86	
30-39	1	5	71	
20-29	0	4	57	
10-19	3	4	57	17.83
0-9	1	1	14	

Table MM174 Percentile calculations for School 3B, Picture Component

Bird	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49	1	9	100	
30-39	3	8	89	
20-29	0	5	56	
10-19	1	5	56	14.5
0-9	4	4	44	

Table MM175 Percentile calculations for School 1A, Picture Component

Dog	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	4	22	96	
80-89	1	18	78	
70-79	2	17	74	
60-69	1	15	65	
50-59	1	14	61	
40-49	2	13	57	42
30-39	0	11	48	
20-29	2	11	48	
10-19	6	9	39	
0-9	3	3	13	

Table MM176 Percentile calculations for School 1B, Picture Component

Dog	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	4	17	100	
40-49	2	13	76	
30-39	2	11	65	
20-29	4	9	53	28.25
10-19	1	5	29	
0-9	4	4	24	

Table MM177 Percentile calculations for School 2A, Picture Component

Dog	School 2A			
	f	Cum f	Cum% f	Median
100	1	16	100	
90-99	0	15	94	
80-89	0	15	94	
70-79	1	15	94	
60-69	2	14	87	
50-59	2	12	75	
40-49	1	10	62	
30-39	1	9	56	
20-29	1	8	50	29.5
10-19	6	7	44	
0-9	1	1	6	

Table MM178 Percentile calculations for School 2B, Picture Component

Dog	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	20	100	
70-79	0	19	95	
60-69	1	19	95	
50-59	2	18	90	
40-49	2	16	80	
30-39	3	14	70	
20-29	3	11	55	26.17
10-19	6	8	40	
0-9	2	2	10	

Table MM179 Percentile calculations for School 3A, Picture Component

Dog	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	2	29	100	
80-89	0	27	93	
70-79	2	27	93	
60-69	2	25	86	
50-59	4	23	79	
40-49	0	19	66	
30-39	2	19	66	
20-29	4	17	59	23.25
10-19	4	13	45	
0-9	9	9	31	

Table MM180 Percentile calculations for School 3B, Picture Component

Dog	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	2	12	100	
50-59	1	10	83	
40-49	0	9	75	
30-39	1	9	75	
20-29	2	8	67	
10-19	3	6	50	19.5
0-9	3	3	25	

Table MM181 Percentile calculations for School 1A, Picture Component

Pear	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	0	22	96	
80-89	4	22	96	
70-79	1	18	78	
60-69	0	17	74	
50-59	2	17	74	
40-49	1	15	65	
30-39	5	14	61	34.5
20-29	1	9	39	
10-19	3	8	35	
0-9	5	5	22	

Table MM182 Percentile calculations for School 1B, Picture Component

Pear	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	17	100	
50-59	0	16	94	
40-49	2	16	94	
30-39	0	14	82	
20-29	2	14	82	
10-19	4	12	71	12
0-9	8	8	30	

Table MM183 Percentile calculations for School 2A, Picture Component

Pear	School 2A			
	f	Cum f	Cum% f	Median
100	2	28	100	
90-99	2	26	93	
80-89	3	24	86	
70-79	0	21	75	
60-69	2	21	75	
50-59	3	19	68	
40-49	1	16	57	
30-39	3	15	54	36.17
20-29	2	12	43	
10-19	2	10	36	
0-9	8	8	29	

Table MM184 Percentile calculations for School 2B, Picture Component

Pear	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49	2	23	100	
30-39	0	21	91	
20-29	5	21	91	
10-19	7	16	70	13.07
0-9	9	9	39	

Table MM185 Percentile calculations for School 3A, Picture Component

Pear	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	25	100	
60-69	1	24	96	
50-59	3	23	92	
40-49	2	20	80	
30-39	0	18	72	
20-29	3	18	72	
10-19	3	15	60	11.17
0-9	12	12	48	

Table MM186 Percentile calculations for School 3B, Picture Component

Pear	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49				
30-39	1	9	100	
20-29	2	8	89	
10-19	0	6	67	
0-9	6	6	67	7

Table MM187 Percentile calculations for School 1A, Picture Component

	School 1A			
Ladybird				
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	0	22	96	
80-89	3	22	96	
70-79	1	19	83	
60-69	1	18	78	
50-59	1	17	74	
40-49	2	16	70	
30-39	2	14	61	
20-29	6	12	52	28.67
10-19	4	6	26	
0-9	2	2	9	

Table MM188 Percentile calculations for School 1B, Picture Component

Ladybird	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	3	19	100	
60-69	2	16	84	
50-59	1	14	74	
40-49	1	13	68	
30-39	1	12	63	
20-29	4	11	58	25.75
10-19	4	7	37	
0-9	3	3	16	

Table MM189 Percentile calculations for School 2A, Picture Component

	School 2A			
Ladybird				
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	0	22	96	
80-89	0	22	96	
70-79	2	22	96	
60-69	2	20	87	
50-59	1	18	78	
40-49	2	17	74	
30-39	2	15	65	
20-29	5	13	57	26.5
10-19	4	8	35	
0-9	4	4	17	

Table MM190 Percentile calculations for School 2B, Picture Component

Ladybird	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	23	100	
60-69	1	22	96	
50-59	2	21	91	
40-49	3	19	83	
30-39	1	16	70	
20-29	7	15	65	24.5
10-19	4	8	35	
0-9	4	4	17	

Table MM191 Percentile calculations for School 3A, Picture Component

	School 3A			
Ladybird				
	f	Cum f	Cum% f	Median
100	1	27	100	
90-99	0	26	96	
80-89	0	26	96	
70-79	1	26	96	
60-69	0	25	93	
50-59	2	25	93	
40-49	2	23	85	
30-39	0	21	78	
20-29	2	21	78	
10-19	6	19	70	10.3
0-9	13	13	48	

Table MM192 Percentile calculations for School 3B, Picture Component

Ladybird	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	8	100	
40-49	0	7	87	
30-39	0	7	87	
20-29	2	7	87	
10-19	3	5	62	16.17
0-9	2	2	25	

Table MM193 Percentile calculations for School 1A, Picture Component

Duck	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	3	21	95	
80-89	4	18	82	
70-79	3	14	64	
60-69	0	11	50	
50-59	4	11	50	59.5
40-49	0	7	32	
30-39	4	7	32	
20-29	2	3	14	
10-19	1	1	5	
0-9	0	0	0	

Table MM194 Percentile calculations for School 1B, Picture Component

Duck	School 1B			
	f	Cum f	Cum% f	Median
100	1	20	100	
90-99	0	19	95	
80-89	0	19	95	
70-79	4	19	95	
60-69	3	15	75	
50-59	3	12	60	52.83
40-49	4	9	45	
30-39	2	5	25	
20-29	1	3	15	
10-19	0	2	10	
0-9	2	2	10	

Table MM195 Percentile calculations for School 2A, Picture Component

Duck	School 2A			
	f	Cum f	Cum% f	Median
100	1	20	100	
90-99	1	19	95	
80-89	1	18	90	
70-79	0	17	85	
60-69	3	17	85	
50-59	4	14	70	
40-49	2	10	50	49.5
30-39	1	8	40	
20-29	4	7	35	
10-19	3	3	15	
0-9	0	0	0	

Table MM196 Percentile calculations for School 2B, Picture Component

Duck	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	2	21	95	
70-79	2	19	86	
60-69	2	17	77	
50-59	5	15	68	51.5
40-49	2	10	45	
30-39	2	8	36	
20-29	3	6	27	
10-19	0	3	14	
0-9	3	3	14	

Table MM197 Percentile calculations for School 3A, Picture Component

Duck	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	29	100	
70-79	1	28	97	
60-69	1	27	93	
50-59	0	26	90	
40-49	4	26	90	
30-39	5	22	76	
20-29	5	17	59	24.5
10-19	1	12	41	
0-9	11	11	38	

Table MM198 Percentile calculations for School 3B, Picture Component

Duck	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	8	100	
70-79	0	6	75	
60-69	2	6	75	
50-59	0	4	50	
40-49	1	4	50	49.5
30-39	0	3	37	
20-29	2	3	37	
10-19	0	1	12	
0-9	1	1	12	

Table MM199 Percentile calculations for School 1A, Picture Component

Camel	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	1	21	95	
70-79	4	20	91	
60-69	1	16	73	
50-59	2	15	68	
40-49	1	13	59	
30-39	3	12	55	36.17
20-29	3	9	41	
10-19	1	6	27	
0-9	5	5	23	

Table MM200 Percentile calculations for School 1B, Picture Component

Camel	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	18	100	
70-79	3	17	94	
60-69	2	14	78	
50-59	0	12	67	
40-49	4	12	67	42
30-39	1	8	44	
20-29	1	7	39	
10-19	3	6	33	
0-9	3	3	17	

Table MM201 Percentile calculations for School 2A, Picture Component

Camel	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	2	22	100	
80-89	1	20	91	
70-79	0	19	86	
60-69	2	19	86	
50-59	0	17	77	
40-49	4	17	77	
30-39	4	13	59	34.5
20-29	5	9	41	
10-19	2	4	18	
0-9	2	2	9	

Table MM202 Percentile calculations for School 2B, Picture Component

Camel	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	2	22	100	
50-59	1	20	91	
40-49	2	19	86	
30-39	1	17	77	
20-29	5	16	73	
10-19	4	11	50	19.5
0-9	7	7	32	

Table MM203 Percentile calculations for School 3A, Picture Component

Camel	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	2	27	100	
70-79	1	25	93	
60-69	0	24	89	
50-59	0	24	89	
40-49	1	24	89	
30-39	5	23	85	
20-29	0	18	67	
10-19	4	18	67	
0-9	14	14	52	9.14

Table MM204 Percentile calculations for School 3B, Picture Component

Camel	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	8	100	
40-49	0	7	87	
30-39	0	7	87	
20-29	2	7	87	
10-19	0	5	62	
0-9	5	5	62	7.5

Table MM205 Percentile calculations for School 1A, Picture Component

Apple	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	2	21	95	
80-89	1	19	86	
70-79	1	18	82	
60-69	1	17	77	
50-59	0	16	73	
40-49	4	16	73	
30-39	1	12	55	
20-29	3	11	50	29.5
10-19	3	8	36	
0-9	5	5	23	

Table MM206 Percentile calculations for School 1B, Picture Component

Apple	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	2	17	100	
60-69	1	15	88	
50-59	1	14	82	
40-49	1	13	76	
30-39	2	12	71	
20-29	3	10	59	24.5
10-19	2	7	41	
0-9	5	5	29	

Table MM207 Percentile calculations for School 2A, Picture Component

Apple	School 2A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	1	21	95	
80-89	0	20	91	
70-79	1	20	91	
60-69	1	19	86	
50-59	2	18	82	
40-49	0	16	73	
30-39	2	16	73	
20-29	1	14	64	
10-19	6	13	59	16.17
0-9	7	7	32	

Table MM208 Percentile calculations for School 2B, Picture Component

Apple	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99	1	23	100	
80-89	0	22	96	
70-79	0	22	96	
60-69	0	22	96	
50-59	0	22	96	
40-49	1	22	96	
30-39	2	21	91	
20-29	2	19	83	
10-19	5	17	74	
0-9	12	12	52	9.08

Table MM209 Percentile calculations for School 3A, Picture Component

Apple	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	29	100	
70-79	1	28	97	
60-69	0	27	93	
50-59	1	27	93	
40-49	2	26	90	
30-39	0	24	83	
20-29	4	24	83	
10-19	1	20	69	
0-9	19	19	66	7.13

Table MM210 Percentile calculations for School 3B, Picture Component

Apple	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49				
30-39	1	9	100	
20-29	0	8	89	
10-19	2	8	89	
0-9	6	6	67	7

Table MM211 Percentile calculations for School 1A, Picture Component

Parrot	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	0	21	95	
80-89	4	21	95	
70-79	3	17	77	
60-69	1	14	64	
50-59	1	13	59	
40-49	2	12	55	44.5
30-39	1	10	45	
20-29	2	9	41	
10-19	3	7	32	
0-9	4	4	18	

Table MM212 Percentile calculations for School 1B, Picture Component

Parrot	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	21	100	
70-79	2	20	95	
60-69	0	18	86	
50-59	2	18	86	
40-49	2	16	76	
30-39	1	14	67	
20-29	6	13	62	25.3
10-19	2	7	33	
0-9	5	5	24	

Table MM213 Percentile calculations for School 2A, Picture Component

Parrot	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	0	21	95	
70-79	2	21	95	
60-69	0	19	86	
50-59	3	19	86	
40-49	2	16	73	
30-39	3	14	64	
20-29	3	11	50	29.5
10-19	4	8	36	
0-9	4	4	18	

Table MM214 Percentile calculations for School 2B, Picture Component

Parrot	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49				
30-39	2	21	100	
20-29	2	19	90	
10-19	3	17	81	
0-9	14	14	67	7

Table MM215 Percentile calculations for School 3A, Picture Component

Parrot	School 3A			
	f	Cum f	Cum% f	Median
100	1	28	100	
90-99	1	27	96	
80-89	0	26	93	
70-79	0	26	93	
60-69	2	26	93	
50-59	3	24	86	
40-49	0	21	75	
30-39	0	21	75	
20-29	4	21	75	
10-19	7	17	61	15.21
0-9	10	10	36	

Table MM216 Percentile calculations for School 3B, Picture Component

Parrot	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	8	100	
60-69	1	7	87	
50-59	0	6	75	
40-49	0	6	75	
30-39	1	6	75	
20-29	1	5	62	
10-19	1	4	50	19.5
0-9	3	3	37	

Table MM217 Percentile calculations for School 1A, Picture Component

Cat	School 1A			
	f	Cum f	Cum% f	Median
100	1	23	100	
90-99	0	22	96	
80-89	0	22	96	
70-79	5	22	96	
60-69	0	17	74	
50-59	3	17	74	
40-49	2	14	61	
30-39	4	12	52	38.25
20-29	3	8	35	
10-19	1	5	22	
0-9	4	4	17	

Table MM218 Percentile calculations for School 1B, Picture Component

Cat	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	0	19	95	
70-79	0	19	95	
60-69	1	19	95	
50-59	2	18	90	
40-49	5	16	80	
30-39	4	11	55	37
20-29	4	7	35	
10-19	1	3	15	
0-9	2	2	10	

Table MM219 Percentile calculations for School 2A, Picture Component

Cat	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	2	22	100	
80-89	1	20	91	
70-79	2	19	86	
60-69	1	17	77	
50-59	2	16	73	
40-49	4	14	64	42
30-39	3	10	45	
20-29	3	7	32	
10-19	2	4	18	
0-9	2	2	9	

Table MM220 Percentile calculations for School 2B, Picture Component

Cat	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	21	100	
60-69	1	20	95	
50-59	0	19	90	
40-49	5	19	90	
30-39	5	14	67	32.5
20-29	4	9	43	
10-19	2	5	24	
0-9	3	3	14	

Table MM221 Percentile calculations for School 3A, Picture Component

Cat	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	30	100	
80-89	0	29	97	
70-79	2	29	97	
60-69	0	27	90	
50-59	4	27	90	
40-49	2	23	77	
30-39	3	21	70	
20-29	4	18	60	22
10-19	4	14	47	
0-9	10	10	33	

Table MM222 Percentile calculations for School 3B, Picture Component

Cat	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	10	100	
60-69	1	9	90	
50-59	0	8	80	
40-49	2	8	80	
30-39	1	6	60	
20-29	0	5	50	
10-19	3	5	50	19.5
0-9	2	2	20	

Table MM223 Percentile calculations for School 1A, Picture Component

Mouse	School 1A			
	f	Cum f	Cum% f	Median
100	2	23	100	
90-99	0	21	91	
80-89	2	21	91	
70-79	1	19	83	
60-69	4	18	78	
50-59	1	14	61	
40-49	2	13	57	42
30-39	2	11	48	
20-29	3	9	39	
10-19	4	6	26	
0-9	2	2	9	

Table MM224 Percentile calculations for School 1B, Picture Component

Mouse	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	1	19	95	
70-79	1	18	90	
60-69	0	17	85	
50-59	1	17	85	
40-49	0	16	80	
30-39	7	16	80	30.93
20-29	4	9	45	
10-19	3	5	25	
0-9	2	2	10	

Table MM225 Percentile calculations for School 2A, Picture Component

Mouse	School 2A			
	f	Cum f	Cum% f	Median
100	2	20	100	
90-99	1	18	90	
80-89	2	17	85	
70-79	0	15	75	
60-69	1	15	75	
50-59	1	14	70	
40-49	5	13	65	43.5
30-39	2	8	40	
20-29	2	6	30	
10-19	3	4	20	
0-9	1	1	5	

Table MM226 Percentile calculations for School 2B, Picture Component

Mouse	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	22	100	
50-59	0	21	95	
40-49	3	21	95	
30-39	4	18	82	
20-29	4	14	64	22
10-19	5	10	45	
0-9	5	5	23	

Table MM227 Percentile calculations for School 3A, Picture Component

Mouse	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	30	100	
80-89	1	29	97	
70-79	1	28	93	
60-69	1	27	90	
50-59	3	26	87	
40-49	2	23	77	
30-39	0	21	70	
20-29	0	21	70	
10-19	6	21	70	
0-9	15	15		9.5

Table MM228 Percentile calculations for School 3B, Picture Component

Mouse	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	6	100	
70-79	0	5	83	
60-69	0	5	83	
50-59	0	5	83	
40-49	1	5	83	
30-39	0	4	67	
20-29	1	4	67	
10-19	1	3	50	19.5
0-9	2	2	33	

Table MM229 Percentile calculations for School 1A, Picture Component

Snail	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	0	21	95	
80-89	1	21	95	
70-79	2	20	91	
60-69	2	18	82	
50-59	4	16	73	
40-49	1	12	55	
30-39	2	11	50	39.5
20-29	1	9	41	
10-19	4	8	36	
0-9	4	4	18	

Table MM230 Percentile calculations for School 1B, Picture Component

Snail	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	2	21	100	
60-69	2	19	90	
50-59	0	17	81	
40-49	1	17	81	
30-39	0	16	76	
20-29	4	16	76	
10-19	3	12	57	14.5
0-9	9	9	43	

Table MM231 Percentile calculations for School 2A, Picture Component

Snail	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	1	22	100	
80-89	0	21	95	
70-79	2	21	95	
60-69	0	19	86	
50-59	1	19	86	
40-49	1	18	82	
30-39	3	17	77	
20-29	7	14	64	25.21
10-19	1	7	32	
0-9	6	6	27	

Table MM232 Percentile calculations for School 2B, Picture Component

Snail	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59				
40-49	1	20	100	
30-39	1	19	95	
20-29	6	18	90	
10-19	4	12	60	14.5
0-9	8	8	40	

Table MM233 Percentile calculations for School 3A, Picture Component

Snail	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	29		
70-79				
60-69	1	28		
50-59	2	27		
40-49				
30-39	1	25		
20-29	3	24		
10-19	4	21		
0-9	17	17		8.03

Table MM234 Percentile calculations for School 3B, Picture Component

Snail	School 3B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	10	100	
40-49	1	9	90	
30-39	0	8	80	
20-29	1	8	80	
10-19	1	7	70	
0-9	6	6	60	7.83

Table MM235 Percentile calculations for School 1A, Picture Component

Fish	School 1A			
	f	Cum f	Cum% f	Median
100	2	22	100	
90-99	3	20	91	
80-89	0	17	77	
70-79	3	17	77	
60-69	1	14	64	
50-59	1	13	59	
40-49	4	12	55	47
30-39	2	8	36	
20-29	3	6	27	
10-19	2	3	14	
0-9	1	1	5	

Table MM236 Percentile calculations for School 1B, Picture Component

Fish	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	2	19	95	
70-79	0	17	85	
60-69	0	17	85	
50-59	4	17	85	
40-49	2	13	65	
30-39	3	11	55	36.17
20-29	2	8	40	
10-19	2	6	30	
0-9	4	4	20	

Table MM237 Percentile calculations for School 2A, Picture Component

Fish	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	4	20	100	
80-89	0	16	80	
70-79	0	16	80	
60-69	1	16	80	
50-59	3	15	75	
40-49	2	12	60	
30-39	2	10	50	39.5
20-29	1	8	40	
10-19	1	7	35	
0-9	6	6	30	

Table MM238 Percentile calculations for School 2B, Picture Component

Fish	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	22	100	
60-69	1	21	95	
50-59	3	20	91	
40-49	5	17	77	
30-39	1	12	55	
20-29	2	11	50	29.5
10-19	2	9	41	
0-9	7	7	32	

Table MM239 Percentile calculations for School 3A, Picture Component

Fish	School 3A			
	f	Cum f	Cum% f	Median
100	1	29		
90-99				
80-89				
70-79	2	28		
60-69	1	26		
50-59	3	25		
40-49				
30-39	2	22		
20-29	7	20		21.64
10-19	3	13		
0-9	10	10		

School 3B – no results

Table MM240 Percentile calculations for School 1A, Picture Component

Squirrel	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	1	23		
80-89	3	22		
70-79				
60-69	1	19		
50-59	1	18		
40-49	2	17		
30-39	4	15		30.75
20-29				
10-19	5	11		
0-9	6	6		

Table MM241 Percentile calculations for School 1B, Picture Component

Squirrel	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	2	20	100	
80-89	1	18	90	
70-79	1	17	85	
60-69	0	16	80	
50-59	1	16	80	
40-49	2	15	75	
30-39	3	13	65	
20-29	1	10	50	29.5
10-19	3	9	45	
0-9	6	6	30	

Table MM242 Percentile calculations for School 2A, Picture Component

Squirrel	School 2A			
	f	Cum f	Cum% f	Median
100	1	20	100	
90-99	0	19	95	
80-89	0	19	95	
70-79	2	19	95	
60-69	0	17	85	
50-59	5	17	85	
40-49	3	12	0	42.83
30-39	0	9	45	
20-29	3	9	45	
10-19	6	6	30	
0-9	0	0	0	

Table MM243 Percentile calculations for School 2B, Picture Component

Squirrel	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	21	100	
60-69	0	20	95	
50-59	2	20	95	
40-49	1	18	86	
30-39	4	17	81	
20-29	5	13	62	24.5
10-19	2	8	38	
0-9	6	6	29	

Table MM244 Percentile calculations for School 3A, Picture Component

Squirrel	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	30	100	
80-89	1	29	97	
70-79	2	28	93	
60-69	4	26	87	
50-59	4	22	73	
40-49	2	18	60	
30-39	2	16	53	34.5
20-29	3	14	47	
10-19	3	11	37	
0-9	8	8	27	

School 3B – no results

Table MM245 Percentile calculations for School 1A, Picture Component

Hen	School 1A			
	f	Cum f	Cum% f	Median
100				
90-99	2	20	100	
80-89	0	18	90	
70-79	4	18	90	
60-69	2	14	70	
50-59	0	12	60	
40-49	0	12	60	
30-39	2	12	60	
20-29	4	10	50	29.5
10-19	3	6	30	
0-9	3	3	15	

Table MM246 Percentile calculations for School 1B, Picture Component

Hen	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	20	100	
60-69	2	19	95	
50-59	1	17	85	
40-49	0	16	80	
30-39	4	16	80	
20-29	3	12	60	22.83
10-19	2	9	45	
0-9	7	7	35	

Table MM247 Percentile calculations for School 2A, Picture Component

Hen	School 2A			
	f	Cum f	Cum% f	Median
100	1	20	100	
90-99	0	19	95	
80-89	0	19	95	
70-79	0	19	95	
60-69	1	19	95	
50-59	0	18	90	
40-49	1	18	90	
30-39	2	17	85	
20-29	2	15	75	
10-19	7	13	65	15.21
0-9	6	6	30	

Table MM248 Percentile calculations for School 2B, Picture Component

Hen	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	20	100	
60-69	0	19	95	
50-59	2	19	95	
40-49	2	17	85	
30-39	4	15	75	
20-29	1	11	55	
10-19	4	10	5	19.5
0-9	6	6	30	

Table MM249 Percentile calculations for School 3A, Picture Component

Hen	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	30	100	
80-89	0	29	97	
70-79	0	29	97	
60-69	1	29	97	
50-59	0	28	93	
40-49	1	28	93	
30-39	0	27	90	
20-29	9	27	90	
10-19	5	18	60	13.5
0-9	13	13	43	

School 3B – no results

Table MM250 Percentile calculations for School 1A, Picture Component

Croc	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	0	21	95	
80-89	4	21	95	
70-79	3	17	77	
60-69	2	14	64	
50-59	1	12	55	
40-49	1	11	50	49.5
30-39	2	10	45	
20-29	6	8	36	
10-19	1	2	9	
0-9	1	1	5	

Table MM251 Percentile calculations for School 1B, Picture Component

Croc	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89	1	20	100	
70-79	0	19	95	
60-69	3	19	95	
50-59	1	16	80	
40-49	2	15	75	
30-39	6	13	65	34.5
20-29	4	7	35	
10-19	1	3	15	
0-9	2	2	10	

Table MM252 Percentile calculations for School 2A, Picture Component

Croc	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	0	19	95	
70-79	1	19	95	
60-69	0	18	90	
50-59	1	18	90	
40-49	2	17	85	
30-39	2	15	75	
20-29	5	13	65	23.5
10-19	3	8	40	
0-9	5	5	25	

Table MM253 Percentile calculations for School 2B, Picture Component

Croc	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69				
50-59	1	20	100	
40-49	1	19	95	
30-39	6	18	80	
20-29	4	12	60	24.5
10-19	3	8	40	
0-9	5	5	25	

Table MM254 Percentile calculations for School 3A, Picture Component

Croc	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79	1	30	100	
60-69	1	29	97	
50-59	1	28	93	
40-49	2	27	90	
30-39	3	25	83	
20-29	8	22	73	20.75
10-19	1	14	14	
0-9	13	13	43	

School 3B – no results

Table MM255 Percentile calculations for School 1A, Picture Component

Horse	School 1A			
	f	Cum f	Cum% f	Median
100	1	22	100	
90-99	0	21	95	
80-89	1	21	95	
70-79	2	20	91	
60-69	2	18	82	
50-59	0	16	73	
40-49	5	16	73	
30-39	4	11	50	39.5
20-29	1	7	32	
10-19	2	6	27	
0-9	4	4	18	

Table MM256 Percentile calculations for School 1B, Picture Component

Horse	School 1B			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	1	19	95	
70-79	1	18	90	
60-69	1	17	85	
50-59	1	16	80	
40-49	3	15	75	
30-39	3	12	60	32.83
20-29	3	9	45	
10-19	3	6	30	
0-9	3	3	15	

Table MM257 Percentile calculations for School 2A, Picture Component

Horse	School 2A			
	f	Cum f	Cum% f	Median
100				
90-99	1	20	100	
80-89	0	19	95	
70-79	1	19	95	
60-69	0	18	90	
50-59	0	18	90	
40-49	0	18	90	
30-39	2	18	90	
20-29	3	16	80	
10-19	4	13	65	12
0-9	9	9	45	

Table MM258 Percentile calculations for School 2B, Picture Component

Horse	School 2B			
	f	Cum f	Cum% f	Median
100				
90-99				
80-89				
70-79				
60-69	1	23	100	
50-59	2	22	96	
40-49	2	20	87	
30-39	4	18	78	
20-29	5	14	61	24.5
10-19	2	9	39	
0-9	7	7	30	

Table MM259 Percentile calculations for School 3A, Picture Component

Horse	School 3A			
	f	Cum f	Cum% f	Median
100				
90-99	1	30	100	
80-89	0	29	97	
70-79	0	29	97	
60-69	0	29	97	
50-59	0	29	97	
40-49	1	29	97	
30-39	3	28	93	
20-29	5	25	83	
10-19	5	20	67	
0-9	15	15	50	0.5

School 3B – no results

APPENDIX NN

PICTURE SCORES

Table NN1 Mean percentages of the picture scores

	School 1		School 2		School 3	
	Group A	Group B	Group A	Group B	Group A	Group B
Children	23	21	23	23	37	17
Flag	80	67	64	73	30	26
Book	67	78	58	74	27	22
House	73	79	66	74	34	19
Boat	70	53	67	59	26	17
Tree	57	51	55	59	30	20
Fence	58	52	57	53	34	22
Sun	46	34	42	39	22	24
Castle	47	46	54	44	24	22
Balloon	39	39	35	37	26	24
Owl	45	31	32	27	21	13
Kite	52	49	46	44	31	26
Car	30	26	27	28	12	13
Flower	35	20	36	21	14	12
Hippo	38	28	36	26	11	14
Tortoise	42	24	31	21	17	15
Tree	43	20	34	18	16	11
Elephant	32	23	27	23	24	18
Bird	45	28	33	25	27	19
Dog	46	29	47	30	32	26
Pear	36	13	29	11	18	8
Ladybird	40	34	33	29	19	19
Duck	63	52	48	49	26	49
Camel	41	39	39	22	19	15
Apple	40	30	31	16	16	10
Parrot	46	32	36	10	26	28

Cat	42	38	45	31	28	31
Mouse	44	30	44	20	20	25
Snail	39	23	30	15	15	15
Fish	53	37	40	30	27	a
Squirrel	37	34	41	25	35	a
Hen	39	26	23	26	17	a
Croc	51	37	27	23	20	a
Horse	40	35	20	25	16	a
Overall lowest	15	7	10	10	1	0
Overall highest	95	69	91	57	80	62

This table summarizes percentage scores achieved for the pictures cut out by the children.

The number of children indicates the group size that participated in the program. There were, however, very many children that were absent, especially in School 3. Either these children were really absent, or their papers were not collected and handed in.

The overall lowest score indicates the child with the weakest cutting skill in the class and the overall highest score indicates the child with the highest cutting skill in the class. Group A of School 1 overall had the best range of cutting ability from 15% to 95%. Group B of School 3 had the lowest score of 0% and Group B of School 2 had the lowest ‘high’ score of 57%.

DIVISION OF PICTURES INTO GROUPS

The maximum point score obtainable is shown next to the picture.

Table NN2 Straight-line designs with few changes in direction

Flag - 6
Book - 6
House - 7
Boat - 10

Table NN3 Straight-line designs with many changes in direction

Tree - 19
Fence - 40
Sun - 20
Castle - 30

Table NN4 Gentle Curves

Balloon - 8
Owl - 14
Kite - 31

Table NN5 Prominent Curves

Car - 11
Flower - 11
Hippo - 13
Tortoise - 7
Tree - 7
Elephant - 10
Bird - 16
Dog - 16

Table NN6 Circular parts

Pear - 10
Ladybird - 17
Duck - 18
Camel - 25
Apple - 11

Table NN7 Many changes in direction

Parrot - 14
Cat - 27
Mouse - 10
Snail - 14
Fish - 12

Table NN8 Complex designs

Squirrel - 18
Hen - 33
Croc - 46
Horse - 29

APPENDIX OO

PRACTICE/PICTURE COMPARISON

Table OO1 Comparison of practice versus picture sections

	School 1		School 2		School 3	
	Group A	Group B	Group A	Group B	Group A	Group B
Straight line	85	80	89	95	61	59
Flag	80	67	64	73	30	26
Wide zigzag	77	81	85	82	52	49
Sun	46	34	42	39	22	24
Narrow zigzag	69	80	75	70	54	40
Owl	45	31	32	27	21	13
Square spiral	68	68	71	80	55	20
Balloon	39	39	35	37	26	24
Frog jumps	70	83	75	81	53	41
Car	30	26	27	28	12	13
Wave	73	79	85	76	62	65
Tortoise	42	24	31	21	17	15
Straight line with bumps	68	70	75	73	47	59
Bird	45	28	33	25	27	19
Narrow waves	66	56	71	67	59	56
Ladybird	40	34	33	29	19	19
Upper and lower circles	68	72	80	65	52	42
Camel	41	39	39	22	19	15
Spiral	77	82	78	71	53	50
Parrot	46	32	36	10	26	28
Circle	62	70	60	57	42	10
Fish	53	37	40	30	27	a

APPENDIX PP

TEACHER RESPONSES

School 1A

This teacher felt pictures were suitable for the children. She enjoyed using the program and felt that children's cutting ability improved markedly. She felt that it did not cut down on preparation time, as she still did other creative activities and did not substitute the cutting program for other activities in her routine.

She felt a little stressed at times, as she thought that each child had to do each page of the program, even when they were absent. This resulted in her trying to catch up with individual children.

School 1B

This teacher felt that the pictures were suitable and she commented that the children looked forward to the program each day. It did not cut down on preparation time for her as she still did all other Grade 0 activities. Overall, she called it a super program and she could see that her children benefited from it.

School 2A

This teacher did not enjoy using the program that much. She felt that it did not save much preparation time and that she was a little stressed using the program. She felt that cutting 4-5 times per week was too much and she was unsure how much the children had learnt. She, however, did find the pictures appropriate.

School 2B

This teacher felt that the pictures were suitable for the children. She was able to see how the children had improved in their skill, especially the cutting motion. She was aware of the bilateral skills involved in the task and the development of this skill throughout the program. She said that the children enjoyed the program and that it became part of their daily routine. In general, however, she felt that the program should run twice per week only, rather than daily. She mentioned that it saved on preparation time for her, as she did not have to plan for this part of her Grade 0 syllabus.

School 3A

This teacher reported that the children enjoyed the pictures and they loved the cutting program. She did the program in groups and she felt that it helped her with her preparation for activities in class. She felt that some exercises were too difficult. She felt that it was a good idea to have a program in the class, yet she felt that she did not have enough time to do this every day.

School 3B

This teacher enjoyed the program and she felt that the children benefited from it. She said it was easy to do and that it saved her some preparation time. She felt that cutting 4-5 times per week was too much.