The effect of a direct instruction motor development program on the catching performance of pre-primary children

Matt Osborne

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Bachelor of Education (Honours)

THE EFFECTS OF A DIRECT INSTRUCTION MOTOR DEVELOPMENT PROGRAM ON THE CATCHING PERFORMANCE OF PRE-PRIMARY CHILDREN.

By

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Date of Submission: September 1995
Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature.

Date .......................................................... .

2/2/96
ABSTRACT

The number of pre-school programs and children attending pre-schools has been rapidly increasing in recent years. The emphasis placed on instruction in physical education and the benefits to be derived from such instruction at the pre-school level have not been directly addressed in the literature. This study examined the effects of a six week direct instruction motor development program on the quantitative and qualitative development of the fundamental motor skill of catching. The participants were four and five year old children who attended a government pre-school attached to a metropolitan primary school. Two children of high gross motor ability and two low gross motor ability children were selected based on the teacher's records of perceived gross motor ability.

The intervention program consisted of three 20 minute instructional activities a week designed at developing critical elements within the skill of catching. A multiple probe design was adopted to measure the effect of the independent variable, the motor development program, on the dependent variable, the catching skill performance of the pre-primary children.

Qualitative measures indicated that following intervention the subjects displayed improvements or stable results in the skill of catching whilst quantitative measures displayed inconsistency between subjects. Qualitative assessments of all subjects were more sensitive to changes in skill acquisition and indicated individual strengths and weaknesses more effectively than quantitative measures. In general, the subjects that received more instruction and practice time displayed greater improvements. Low gross motor achievers required more instruction and practice time than high achievers to improve the skill of catching.

Teachers and parents must understand that unless children receive the opportunity to practice and quality instruction needed to develop fundamental motor skills at an early age their future participation in a range of physical activities may be affected. Further research needs to investigate ways in which quality programs can be instigated and maintained within schools so that all children have an equal opportunity to a quality physical education program.
Acknowledgements

I acknowledge with sincere thanks and appreciation my supervisor, Dr. Andrew Taggart, for his support, patience, encouragement and guidance throughout the period of my thesis preparation.

A number of people offered support and assistance during the compilation of this thesis. I sincerely thank them all for their help.

Without the constant support and understanding of my family and friends, I would never have been able to complete this thesis.
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INTRODUCTION

Background to the study

The number of children under the age of five who are attending pre-schools has rapidly increased over the last twenty years. Ames (1980) believes that increased growth in the pre-school population can be attributed to a variety of changes in society. Two of the more commonly stated explanations relate to day care in the case of working parents and the desire of parents to prepare their children for school. Many parents believe that a good pre-school education can teach their children basic skills needed to be "ready" for further learning. Unfortunately many readiness goals set by parents and teachers are centred around the cognitive domain of learning whilst the affective and psychomotor domains are considered to be of secondary importance.

Often in our rush to give children a head start in pursuit of academic excellence, we, as parents overlook a vital part of the child's development. The motor system forms a foundation for the growth and expansion of all human organisms. It must be carefully nurtured.

(Capon 1977, p. 3).

Although pre-school practitioners have different philosophies as to what is a quality pre-school curriculum, many believe that one component recommended almost universally for
inclusion is an emphasis on gross motor activity, particularly the fundamental motor skills of throwing, catching, running and climbing. A recent study by Walkley, Holland, Treloar and Probyn-Smith (1993) revealed that Australian boys and girls in grades two, four, six and eight are all below expected levels of competence when executing fundamental motor skills. Grineski (1988) believes that through a directed gross motor program, young children have the opportunities to develop and refine the fundamental movement patterns of nonlocomotion, locomotion, and manipulation. "This acquisition would provide young children with feelings of success, ability to participate in simple movement activities, and the motor skill foundation necessary for successful participation in sophisticated games, dances and sports to be learned during childhood and adolescence" (p. 91).

Arnheim and Sinclair (1979) believe that the implications of not learning basic gross motor skills in the early years of development can cause self concept and self esteem problems, and later channel children away from sports in which they may wish to participate, either competitively or as recreation. The implications of young children not learning fundamental motor skills in their early years may lead to an increase in the number of low fitness children in upper primary and secondary school. Leading researchers (Gallahue, 1993; Larkin, Hoare & Smith, 1989) studying the fitness levels of young children in primary schools support the view that early experiences in gross motor development can be one of the reasons for non-participation in physical activity and hence the development of health related problems later in adolescence.

While there is a consensus on the value of gross motor activity in pre-schools, there is considerable variation on why this goal is perceived as important and how this goal is
achieved. For example, some educators firmly believe that the development of fundamental motor skills in young children should be left for the children to discover and further explore themselves whilst others take the view that good instruction on skills early in development leads to more efficient movement patterns for later stages in development.

**Significance of the study.**

Physical education is part of the total educational process and without it, education is incomplete. Walkley et al. (1993) stress the need for further research into physical education and questions whether children in Australia are receiving the "total" educational process as many appear to lack quality physical education experiences in the early years of schooling.

According to Browning and Schack (1990) a major part of physical education is motor skill development designed to promote competence at all age levels. "Competence, in turn, can provide for good self-esteem, enjoyment of activity, and lead to participation in sports and games during one's leisure time" (p. 144). Although physical education can claim to impact on many of the general goals of education, its unique contribution is to the psychomotor domain of education.

Many pre-primary and primary schools have physical education programs which, according to the philosophies of the pre-school teachers, are named in a number of different ways. Variations in the physical education programs range from unstructured free play periods to structured movement obstacle courses. The unstructured free play
periods characteristically consist of the children playing between themselves with little equipment available or set up by the teacher. Opposed to this unstructured version are the structured learning environments which consist of obstacle courses and small working stations where the children are given clear instruction and feedback by the teacher. Wetton (1988) states clearly that, "there should be at least one period of teacher-structured physical education each day" (p. 6).

The following diagram displays the degree of the planned learning environment with the structured and unstructured environments at either end of the continuum.

\[
\text{Experiential} \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \qua
Kelly et al. (1989) found that when pre-school children were subjected to a twelve week assessment based instructional physical education program of six fundamental motor skills, significant gains on all six skills were evident. Van der Mars & Butterfield (1987) found that an eight week highly structured instructional program was successful in improving the fundamental motor skills of running, throwing, catching, jumping and ladder climbing while a control group showed no improvement between pre- and post- test measures. Both of these studies conclude that in a structured environment accompanied with good instruction and feedback, changes in gross motor movements in pre-school children can be made. Wickstrom (1983) and Siedentop, Herkowitz and Rink (1984) all believe that if young children receive a well developed motor program incorporated with accurate feedback on performance then development of any skill will increase through its maturational stages.

This study addresses the issues of how much instruction is needed to bring about both quantitative/functional success and qualitative/topographical technique changes in motor skill performance of pre-primary children. Whilst all fundamental motor skills are important to young children, the skill of catching will be investigated due to the low skill level demonstrated by so many young children and the apparent difficulty teachers have in analysing and teaching the skill.
Statement of the problem.

Catching is a fundamental motor skill that is a vital component of many play activities and recreational games played in the primary school setting. In the simple games played in the playground, a medium sized ball or small ball are used, and boys and girls tend to play together. Without the skill of catching being developed and refined between the ages of four to six years, many children would be deprived of the basic right to participate in these games and activities that form an important part of a child's education. Furthermore, if children in the primary school years are not given the opportunities to practise the skill of catching in the playground setting, then later in their lives they may not be able to confidently pursue leisure or recreational games that require the skill of catching (Walkley et al., 1993).

Due to the increasing demands on school time by both traditional and new curriculum areas, many primary school children are not given opportunities to play and explore skills such as catching. Formal instruction, the provision of planned learning environments and opportunities to practice motor skills are often rare occurrences in pre-primary settings.

Although some deficiencies in catching may be attributed to maturational factors, many gross motor performance problems can be addressed by effective teaching. According to Gallahue (1989), Roberton and Halverson (1984) and Diem (1982) gross motor development does not occur automatically, but instead is influenced by environmental factors. Environmental factors, such as the quality of instruction, opportunity to practice, and the interest and encouragement provided by others to a child have been shown to play
a significant role in the development and maintenance of fundamental motor skills. Halverson and Roberton (1977) have found that changes to pre-school children's throwing abilities can be made in both functional responses and topographical measures over an eight week period. Little research has been done to study the effects of instruction on the catching ability of pre-school children using both functional responses and topographical measures.

The purpose of this study was to focus on the gross-motor skill of catching of pre-primary children, and investigate whether an instructional motor development program has an effect on skill performance over a six week period. If this instructional program should prove successful in improving the skill level of pre-primary children, then it may be evident that children of a young age should be given some type of instruction early in their education so that later on they can further develop and refine these skills and pursue an active and healthy lifestyle. Due to the applied nature of this investigation, the motor development program implemented may become a valuable resource for pre-primary teachers assessing and teaching the skill of catching.

In summary, this chapter has highlighted that the pre-school and early primary years have been suggested as the best time for children to learn and refine motor skills. Also, the early detection of motor problems and the start of intervention programs can eliminate or minimize some physical and related emotional problems (Arnheim & Sinclair, 1979). Walkley et al. (1993) found that many children are not developing competence in fundamental motor skills as would be expected and further research into this area needs to be undertaken.
REVIEW OF RELATED LITERATURE

This review of literature will examine the development of gross motor skills and related movement programs in pre-schools. The process of the skill of hand catching will be carefully analysed as will the variables that affect catching. The review will also address the research on effective teaching in physical education and related methodological considerations.

Development of gross motor skills in young children.

According to Seefeldt (1984) a primary task of pre-school children is to learn how to move efficiently. This is a huge challenge when one considers the short time in which movement efficiency is to be accomplished. When we trace the motoric progress of children, it becomes evident that the early years of life are critical to their learning gross motor skills.

Evidence has shown that the rudimentary skills which make up the components of our games and sports can be learned by children in an enriched environment before they are six years of age.

(Seefeldt, 1984, p. 35)

This statement emphasizes how important it is for children in their early years of development to be introduced to basic fundamental motor skills. Williams (1983, p. 200) states that "gross motor development is commonly referred to as development of
fundamental motor skills. Fundamental motor skills include walking, running, jumping, hopping, galloping, and skipping, and the ball handling skills of throwing, kicking, striking, catching and bouncing. Her research indicates that fundamental motor skills are characteristic of the motor development of the child from three to six years of age and appear to be pre-requisite to the acquisition of efficient movement skills in general, and set the foundation for the development of more specific task related motor skills that are an integral part of motor performance at all age levels.

Broadhead and Church (1985) who explored movement characteristics of pre-school children, discovered that when using the DIAL test (Developmental Indicators for the Assessment of Learning) girls are superior in fine motor areas whilst boys are superior in gross motor movements. It was concluded that to fully understand the implications of these results, age groupings, social class matrix and ethnicity of the subjects would need to be further researched. The difference in abilities between boys and girls in fine and gross motor performances found by Broadhead and Church can be attributed to environmental factors. The amount and quality of instruction, opportunity to practice, interest and encouragement provided by others toward a child, and expectations placed on the different sexes by society, all contribute to these differing levels of motor performance. Walkley et al. (1993) investigated the fundamental motor skill proficiency of children in grades two, four, six and eight. Both, boys and girls performed the catch, overhand throw, instep kick, forehand strike and two handed strike. Qualitative assessment of subjects' performance identified that subjects at all grade levels lacked competence in motor skills assessed. In general boys performed better than girls and older subjects performed better than younger
subjects. A disturbing revelation was that the competence of girls at year eight was inferior to the competence of girls at year six for each skill except the two-handed sidearm strike. One of the major recommendations of this study was that more emphasis needs to be placed on the development of fundamental motor skills among primary school children.

Teachers of physical education, be they specialist trained or classroom teachers, need to focus their instruction toward the development of fundamental motor skills from the early grades of school and this may necessitate drastic curriculum change.

**Motor development programs in pre-schools.**

Van der Mars & Butterfield (1987) investigated the effects of a performance based curriculum on the gross motor development of pre-school children and discovered that the 15 treatment group children scored significantly higher on gross motor tasks than the control. The experimental group which included eight boys and seven girls were exposed to eight weekly 40 minute sessions (a total of 320 minutes) based on the Performance Based Curriculum developed by Loovis and Ersing (1979). The Performance Based Curriculum are teaching learning experiences that are sequentially arranged instructional activities based on task analysis. A task analysis is a systematic process of breaking down the performance goal/skill outcome into linked sub-parts that when performed in the correct sequence meet both the topographical and functional requirements of the skill. The fundamental motor skill that showed the most significant gains after pre- and post-test measures was catching. Pre-test measures within the treatment group showed the
boys to be superior in catching to the girls. This advantage had disappeared by the end of the intervention period emphasizing the value of direct instruction in overcoming socially determined differentials in motor skill development.

The study by Van der Mars and Butterfield indicates that even in a structured environment with minimal instruction, gains in gross motor performance of young children are significantly higher than children who do not participate in such programs. The second major finding of this research relevant to this study is that girls may benefit more than boys from involvement in such highly structured programs. Sex differences found on the pre-test data decreased as a result of involvement in the Performance Based Curriculum.

A similar study was conducted by Kelly, Dagger and Walkley (1989) whereby the effects of a twelve week assessment based instructional physical education program on the qualitative development of six fundamental motor skills in preschool children was researched. The experimental group received 50 minutes of instruction in physical education two days a week for twelve weeks. The instructional program was designed by the investigators in accordance with the Achievement-based Curriculum Model (Wessel & Kelly, 1986). The twelve weeks of instruction were divided into two 5-week instructional units, each of which was proceeded and followed by an assessment period. Each 5-week unit focused on the development of three motor skills. The six motor skills studied were jumping, kicking, throwing, striking, catching and rolling. The subjects in the experimental group scored significantly higher in all motor skill areas when compared to the control group, who received supervised play during the intervention. The fundamental
motor skill of catching displayed the greatest improvement at the conclusion of the intervention than any other skill.

Werner (1974) studied the effects of an eight week program of guided instruction in locomotor, stability and manipulative patterns on the physical performance of pre-school children. Three days each week, twelve physical education majors took turns teaching physical education lessons to the treatment group. Two days each week involved setting up activity stations as part of the children's one hour free play period. Two or three activity stations were created each day. The children could freely choose to participate at one of the activity stations or become involved in one of the learning experiences provided by the pre-school teacher. During the third lesson each week, the children were brought together and taught as a class for 20 minutes. All lessons were planned using a movement exploration approach. The results of the program showed significant improvement in motor patterns and that there was no significant difference in performance of the boys and girls in these motor patterns.

Halverson, Roberton, Safrit and Roberts (1977) randomly assigned forty five children by sex from two intact kindergartens in one school to (a) an experimental group which received a movement program that included 120 minutes of guided practice in the overhand throw over an eight week period, or (b) a control group which received the same movement program but no exposure to the throw. Twenty four additional kindergarten children from a comparable school were randomly selected by sex for a second control group. They received no movement program and no formal assessment. During the 12 periods, organisational plans varied from those in which the total group practised together
to those in which individuals worked with the teacher while other children pursued self-directed practice on different motor tasks. It was estimated that each child received a total of 5 to 15 minutes per period of guided practice. The primary purpose of the guided practice was to effect maximum progress toward more advanced developmental levels of throwing. The teacher used total group practice, individual work with the children and self-directed practice on different motor tasks. The main emphasis was on the setting of force goals with a stress on auditory and visual knowledge of results related to these goals.

Auditory knowledge of results was provided by turning the attention of the children to the different sounds balls of varying velocities made when hitting the wall. Visual knowledge of results was provided by having the child note the amount of ball rebound that resulted from varying velocities of the throw. The teacher also helped individual children through verbal cues and demonstrations.

Before and after the eight-week instructional period, ten trials of each child's overhand throw for force were filmed. These records consisted of side view motion pictures taken simultaneously with direct, horizontal ball velocity recordings. The major finding of this study was that guided practice did not significantly change the ball velocities of the overhand throw of kindergarten children. One explanation for the results was that 120 minutes over an eight-week period was not enough time to make a difference in children's ability to produce force in so complex a task as the overhand throw. The other important finding reported was that "velocity" is a product type measurement. Since velocity is the product of a complex interaction of movements, development within any part of this complex might not be immediately reflected by the velocity score. Developmental changes in
movement could be occurring which would ultimately be important to the final organisation of the throw. Later analysis of films, taken originally to measure velocities of the throws, found that significant changes to the "form" or movement pattern used in throwing occurred. Thus a single measure or indicator of fundamental motor skill performance may be inadequate for fully describing the nature and/or level of such performance in young children.

Although this study investigated the changes in throwing velocities of kindergarten children, it is relevant to note that sufficient time must be allocated during the intervention to allow changes to occur and that the instruments used to collect information must be selected to measure the product and process characteristics in order to develop a full description of skill acquisition.

It appears from a review of the limited number of studies completed in this area that when planning a catching intervention study with pre school children, consideration must be given to;

- a structured teaching environment
- task analysis of the skill of catching and subsequent instruction that relates to the critical elements identified.
- guided practice
- effective auditory and visual feedback
- sufficient time to develop and further refine skills.

If these aspects are considered within the intervention period, previous research suggests that changes to skill performance can be made. Perhaps the most important aspect to note
from the reviewed research so far is that two dimensional description or assessments of
two-dimensional description or assessments. The two dimensions of assessment should include how the
classroom environment and what the results of the movement are. The following section will review
the specific aspects of the catching process in young children and the variables that affect
this process.

The catching process

The catching process of pre-primary children was selected as the focal movement pattern
for this investigation because of its importance in play, games and sports, its appeal to
children, the high degree of visual-perceptual abilities required to achieve success and
how pre-primary programs may be enhanced if the process is better understood for
children at this age level.

According to Siedentop, Herkowitz and Rink (1984), "catching as a fundamental skill,
involve the use of hand(s) and or other parts of the body to stop and control an aerial ball
or object" (p. 87). Although this definition is very broad, the standard for skilled catching
is not. The model for the mature form of hand catching is agreed to by Wickstrom (1983),
catching as being, "the standard for evaluating effectiveness and efficiency in most
research in catching technique, and it is the form used commonly in sports in which ball
catching is a major skill" (p. 137).
Playground games such as football, baseball, softball, netball and basketball are all varying forms of catching an aerial object. To successfully participate in these games the participants must be able to catch the ball in their hands. Williams (1983) believes that the level of hand catching can be developed by the age of five years, but as development varies between individuals so does skill. Many pre-primary children characteristically catch balls on their chest, trapping the ball with their arms. Wickstrom (1983) suggests that "when other body parts are used in combination with the hands the act then becomes a form of trapping" (p. 137).

In summary it appears that five year old children are capable of catching a ball using their hands and other parts of their body. It is important to note that the form of catching referred to in this literature is two hand, chest high or below the waist catching. Catching above the shoulder or over the head refers to variations in catching which would be studied in sport skill studies. The following section will demonstrate what variables may affect the catching process.

Variables of catching

Wickstrom (1983) clearly indicates that catching behaviour can be very difficult to study because of the number of variables influencing the measurement of performance.

The major variables that may influence catching performance are:

1. the size of the ball
2. the distance the ball travels before it is caught
3. the method of projecting the ball
4. the direction of the ball in relation to the catcher
5. the speed of the ball
6. the pre-catch change of position required
7. the arm-hand action of the catcher
8. age related sensory and perceptual factors

(Wickstrom 1983, p. 138)

Despite the evident difficulty of learning to catch, Wickstrom (1983, p. 138) states, that "both boys and girls tend to show improvement in catching skill each year and at successive grade levels through the primary school years and beyond". The improvement trends are based upon success in catching increasingly smaller balls and upon greater effectiveness when using hand-catching technique. It is important to note that the variables that effect catching performance should also be taken into consideration when assessing catching and developing a program to improve catching. The following section presents the findings of research that has endeavoured to measure the effects of these variables on catching performance.

Size of the ball

Is a large, medium or small ball most conducive to successful catching? The effects of ball size on catching has been investigated extensively but discrepancies in the findings do exist. Hoadley (in Wickstrom 1983, p. 138) constructed a throwing machine capable of projecting three different sized balls in her study of the catching ability of 250 school
children in grades one through to four. The results of this study found that boys and girls improved in the ability to catch large and small balls at successive grades. At the first grade level Hoadley observed no sex difference in catching the large balls. Hoadley's study is significant because it indicates that there should be little or no difference in catching ability between sexes in the earlier years of school and that young children can catch both large and small sized balls, thus supporting the impact of environmental variables on performance.

Ridenour (1977) studied the influence of object size, speed, direction, height and distance on successful object interception when second grade children used a paddle to strike a moving object. This study revealed that the large balls were intercepted less frequently than the small ball when it moved directly toward the child's midline. Ridenour suggests that teachers who desire to increase the frequency of object interception should avoid the projection of large balls directly toward the midline of a child from a point that is also directly in front of the child's midline, since the movement detection of large balls may be more difficult during these conditions and may therefore reduce the frequency of striking contact. These findings have implications for the way in which this study will conduct the catching testing procedure.

Payne (1981) investigated the effects of various ball diameters on the object reception of first grade children. A special device was designed to accurately project the balls with a consistent speed and trajectory. The subsequent catch, or attempted catch, was evaluated using a five point rating scale: 1, failure to react; 2, one hand contact, ball dropped; 3, two hands contact, ball dropped; 4, uncontrolled catch (ball is bobbled); 5, controlled catch.
This scale was then used to quantify the success of the catching attempt. The results from this study determined that the 10 inch diameter ball resulted in significant superior catching performances than the ball with a 6 inch diameter. No significant difference was noted between the 10 inch ball and the 8.5 inch ball nor between the 8.5 inch ball and the 6 inch ball size for this design situation.

Belka (1985) also investigated the effects of ball sizes on the catching process of 15 male and 15 female children aged six, eight and ten. Balls of diameters 12.7cm, 17.8cm, and 21.6cm were thrown underarm from a designated release point (3.96m) to a child's chest height. Each catch was assessed using the Cashin's catching process scale (in Belka 1985). The results showed no significant differences in ball size, but mean scores of the three ball sizes produced significant age level differences in the catching process. The eight year olds were superior to the six year olds whilst the ten year olds' scores were greater than both the younger age groups' scores. There was no significant difference between scores for males and females.

A more recent view by Isaacs (1980) summarises the research completed on ball size and its effect on catching, whereby he states:

Research strongly indicates that the use of large balls tends to encourage less than mature styles of catching. In addition, the skill of catching is difficult enough without the child having to worry about being injured by the projectile. The use of a smaller and softer ball may aid the child in feeling more comfortable about the task.

(Isaacs 1980, p.57)
The earlier view on ball size, which still may be evident in many existing programs, was that larger balls were easier to catch. These earlier studies were based on stopping and securing the ball rather than on the developmental aspects of the catching process. Both Morris (1980) and Berkowitz (1978) indicate that the balls of medium size are easiest to catch, with larger balls more difficult and smaller balls most difficult. Neither author defined the exact diameters of the specific balls. There remains a definite need to obtain more precise information concerning the effects of ball size on the catching process in children at different ages.

Distance the ball travels

According to the literature the horizontal distance that the ball travels appears to be more important than ball size in contributing to catching success. The distance the ball travelled and the size of the ball was investigated in Warner's study (in Wickstrom 1983, p. 138) of the motor ability of third, fourth and fifth grade boys. The findings of this investigation will be expressed with respect to the youngest group.

A ball was tossed to the catcher at chest height from a distance of twenty feet. Five trials were given with a volleyball and five with a tennis ball. Five catches out of 5 attempts with the volleyball were scored by 70.1% of the third grade boys. The results showed that no one failed to make at least 1 catch with the larger ball when including the fourth and fifth grade boys. A perfect score on five attempts with a tennis ball was made by 57.5% of third graders. Less than 1% of the third grade boys failed to make at least 1 successful
catch of a tennis ball. Warner's study demonstrates that as distance increases and ball size decreases the skill of hand catching becomes increasingly more difficult.

Ridenour's (1977) study also concluded that in general, balls moving a shorter distance were intercepted more frequently than balls moving a larger distance. However, as Belka (1985) highlights in his discussion, if trajectory is held constant, then increasing the horizontal distance for catching also increases the speed of the ball for that particular catch. Thus, distance becomes a speed/distance factor requiring further investigation, either alone or in combination with other factors. In measuring the distance/speed factor on the catching process he discovered significant differences. Throwing a medium sized ball (17.8cm in diameter) from 2.44m, 3.96m, and 5.49 m at chest height to six, eight and ten year old boys and girls, he found that scores for the smaller distance were more superior to scores for both of the other distances; and the intermediate distance was more superior than the furthest distance. The ten year olds' scores were greater in magnitude than the eight year olds' and the eight year olds' were superior to the six year olds'.

Gender produced significant differences, with mean scores for males superior to mean scores for females. As age increased, distance scores increased significantly.

These studies highlight the fact that the distance between the catcher and the method of projection can have a very powerful effect on the catching process. Important points to note from this review are that as distance increases skill efficiency is likely to decrease depending on the age of the subjects and that medium sized balls are most likely to be caught more often. The reason for decreased skill level as distance increases has been
suggested in the literature to be an increase in speed if projectory is kept constant.

The size of the balls used during the testing procedure for this study will be a medium sized ball (18cm in diameter) and a tennis ball (9cm in diameter) that will be projected from a horizontal distance of three, four and five metres.

**Trajectory and velocity**

The parabolic flight path of a tossed ball depends on a number of parameters, two of which are the projection angle and the projection velocity. According to Laslow and Bairstow (1985, p. 28) a mature catcher can catch on a wide variety of trajectories, including direct frontal and lateral approaches, as well as trajectories not aimed directly at the subject.

Varied trajectory and velocities of the ball and in several experimental conditions requiring the catcher to move in preparation for catching was a major feature in Bruce's (in Isaacs, 1980) investigation of catching behaviours of second, fourth and fifth grade children. A ball throwing machine controlled the projection of the tennis balls at either 60 degree or 30 degree angles, and each catching attempt was rated on a carefully devised 5 point scale. His findings verified both the expected improvement of performance with advancing grade level and the anticipated superiority of the catching performance of boys.

Part of the findings showed that second grade children experienced substantial difficulty when it was necessary to adjust by moving forward or backward to catch.

Belka (1985) investigated the effects of height of interception on the catching process with six, eight and ten year old boys and girls. Ten catching attempts were administered for
each of three heights: chest, waist and knee height. One diameter ball (17.8cm) was used and thrown from a distance of 3.96m. The results of this study showed that chest height catches were easier for all age groups to catch and that as age increased so did performance. As a group males scored significantly better than females.

The literature clearly emphasizes that when conducting an intervention with young children aged six to ten years, the trajectory of the ball during the testing procedure should be directed toward the chest of the subject with the trajectory being constant and predictable.

**Lateral ball location**

McConnell and Wade (1990) investigated the effects of lateral movement on the quality and quantity of catching as they interact with age. A ramp was constructed which slowed the descent of the 4 inch fleece ball so that it took 1.8 sec. to arrive at the child's location. Each ball could be delivered to one of five different locations in relation to the child. A ball was rolled down the ramp 15 times for each subject. The first five trials were not recorded. The distribution for the holes was based on a random table for five numbers. The results of this study reported that the mean number of catches made increased from kindergarten through the fourth grade for both boys and girls. In the kindergarten the researchers found that balls rolled a foot to the left and right were, in fact, easier for students to catch than balls rolled directly towards them. The researchers explained that the reason why the balls slightly off centre were easier for kindergarten children to catch was because;
the peripheral visual system triggers an initial ballistic movement, which brings the moving limbs to the general vicinity of the ball and that the central visual system operates as a closed loop system to provide the final adjustments necessary to catch the ball. It may be that the system begins operating faster when the ball is slightly off centre.

(McConnell & Wade 1990, p. 65)

The implications from these findings suggest that when testing young children on the skill efficiency of catching, the teacher should throw or bounce a ball slightly to the left or the right of the subject to ensure the child has sufficient visual cues to perform the task.

Perceptual development

According to Gallahue (1989, p. 325) there is little doubt that the developmental level of one's visual perceptual abilities will have an impact on the performance level of movement skills. The following table will give a brief outline of the child's developing perceptual abilities and their perceptual impact on skill development and refinement. Visual acuity, figure ground perception, depth perception and visual motor coordination are all important visual perceptual qualities that are developmentally based and influence movement performance.
### Table I

**Summary of perceptual development for children between five and twelve years of age.**

Table 1 demonstrates that pre-primary children of approximately five years are at a stage in development where their visual acuity and visual motor co-ordination are rapidly improving, with slow improvement in figure ground perception. It appears that whilst all visual qualities are improving at such a fast rate that teaching the skill of catching would be both appropriate and advantageous to the developing child. Perceptual development as well as motor development is crucial to successful movement performance. The next
section will review studies that have investigated the effect of visual perception cues on children of approximately the same age group.

Visual perception cues
Catching an object depends on having knowledge of the object's distance, path of approach and its speed. Laslow and Bairstow (1985) state that,

the subject's knowledge may be of an implicit kind, with the activity being performed without an explicit judgement being made. Whatever the kind of knowledge, perception of the parabolic flight path of a ball, which varies slightly every time it is tossed, poses significant problems for the developing child. (p.29)

Torres (in Wickstrom 1983, p. 139) studied the relationship between figure ground perceptual ability and ball catching ability in 10 and 13 year old boys and girls. The result of this study found no differences in ground-figure perceptual ability at either age level, but both sexes in the older group were better in this visual perceptual ability.

Hellweg (in Wickstrom 1983, p. 139) analysed the perceptual and performance characteristics of the catching skill of the best and the poorest of a group of six to seven year old children. The 10 best and 10 poorest catchers were selected on the basis of ratings by three judges who used a five point scale. The two groups were tested and found to have equally mature visual systems. They were also tested on the ability to judge the path of an approaching ball and indicate when it arrived at a pre-determined point, and again there was no significant difference between the groups.
MacGillivray (1979) tried to determine the relationship between perceptual style and viewing time of 90 male students between the ages of 10 and 11 years. These individuals were tested for field dependence (FD) and field independence (FI) on a portable rod and frame test. The 45 subjects in each perceptual style classification (FI and FD) were then randomly assigned to different viewing treatments. The subjects practised a ball catching task for a period of 8 days, with 30 practice trials each day. The catching task for them required the subjects to attempt to catch a tennis ball with their preferred hand, projected from 20 feet at a velocity of 40 ft/sec with an interception point 54 inches from the ground. The scoring of the task was that if the subject caught the ball then they received two points, if they made contact but dropped the ball they received one point and failure to make contact scored zero. The results showed that catching was increasingly more effective as viewing time progressed from 150 to 250 to 350 milliseconds. Subjects who were field independent performed better at the 2 shorter viewing times, but perceptual style made no difference at the 350 millisecond level.

These studies indicate that although catching is considered to be a very difficult perceptual motor task, young children enhance the necessary visual systems that can be further developed to master the skill of catching. The study by Torres demonstrates that as children become older, boys tend to become more superior to girls. A possible explanation for boys tending to score higher than girls is that boys are encouraged to practise more ball games than girls.
Ball Colour

The effect that ball colour has on one's catching ability is questionable. Different procedures have been used to research this factor, and the research has yielded a variety of interesting findings. In studying the effects of ball and background colour on the catching performances of young children, Morris (1976) found that both blue and yellow balls were caught significantly better than white balls. Further more, the children's highest catching scores were obtained when the blue balls were projected against a white background.

Roirdan (in Wickstrom 1983, p. 142) studied 32 pre-school children who practised catching an 8 inch ball that had been propelled by a two hand chest pass from a distance of 15 feet and had bounced on a line 3 feet in front of them. After four and a half weeks practice the 3, 4 and 5 year old children were given 10 trials with red, yellow, and white balls. Neither the age nor the sex of the children affected their catching efficiency, but they were able to catch red and white balls significantly better than yellow ones. Colour preference did not have a significant influence on the catching ability of the group.

The implications of the above research suggest that providing a contrast between ball and visual background should aid the child in the visual operations of differentiating between the appropriate display (ball) and irrelevant or secondary displays (background). In addition, the background from which the ball is projected should be kept simple. Teaching young children catching skills in the playground where the background may consist of passing cars and/or the movement of others playing may further complicate the task.
Summary of the variables in catching

The previous literature has examined some of the pertinent factors which have been found to influence the catching performance of young children. To facilitate clarity of discussion each factor has been presented independently of other factors. It is important to be aware that these factors interact and in combination are more difficult to study than factors in isolation. Most types of catching in these studies focus on the mature form of catching and have entirely measured functional (success/non success) type catching. For example, performance is measured on the end product, not the type of technique (topography) or near miss that may have occurred. Whilst all of the studies have mentioned the variables that may influence catching ability, it can not be overlooked that these same variables must be considered when developing a program based on improving catching ability.

Certainly pre-primary teachers need to have at least a general understanding of the important variables that affect the development of fundamental motor skills such as catching. The following information will discuss important elements that must be considered when assessing catching performance.

Analysis of the topography in catching

Two approaches can be used to assess physical skills. The first and easiest involves measuring a product or functional response (performance results). If the product or result of movement has more than one dimension (e.g., throwing velocity and accuracy), these dimensions are referred to as product components. The result of the movement or product...
is a reflection of the movement itself and, therefore, product measures are valuable measures of performance. If the product measure is specific enough, it may in fact help to identify process errors. For example, if an accuracy measure (product) indicates direction of deviation from the target (as in throwing at a target), information concerning body position at release or contact is available. It is important to note, however, that some movement skills cannot be evaluated in a meaningful way by use of product scores. Catching is a good example. There is no meaningful distance, velocity, or directional component to catching performance. The practitioner who wants to assess catching ability would make a judgement on catching ability from the number of catches successfully caught. Although this type of assessment uses performance to measure skill level, it does not provide an insight into understanding how the skill was performed. The second and more difficult method of assessing physical skills is process or the topography (form) evaluation. Process evaluation focuses on the quality of movement. Rather than measure results, process evaluation takes place during the performance. In determining catching ability, a process evaluation would focus on the way the hands and arms are positioned throughout the preparation and action phases of catching. Process evaluation, however, making the observer aware of skill level variation, can prevent improper form from limiting performance by selecting appropriate activities to improve skill.

Unlike hitting and overarm throwing the act of catching is not performed so quickly that many features are lost to visual observation. As Wickstrom (1983, p. 159) suggests, "simultaneous contact and closure are the most difficult aspects of the pattern to perceive". The other critical elements are certainly observable to the trained eye.
Wickstrom's research indicates that when analysing catching, attention should be made towards the preparatory actions and the final actions. Items which should be looked for include:

1. Promptness and accuracy of body position in relation to trajectory of the ball.
2. Outstretching arm position with elbows bent.
3. Hands being in position to intercept the ball prior to contact.
4. Hands contact only.
5. Retention of the ball.  

(Wickstrom 1983, p. 161)

Morton (1991) has adapted Wickstrom's broad guidelines to the analysis of catching and refined these points to five critical elements. The five critical elements are as follows:

1. Semi-flexed elbows pointing downward.
2. Hands reach out in a cup shape, and grab the ball in unison.
3. Give with the ball.
4. Eye contact continuous until ball is caught.
5. Feet in stride position.  

(Morton 1991, p. 88)

Both models suggested by Wickstrom (1983) and Morton (1991) focus on the qualitative (topography) measures of assessing catching. Little previous research has been conducted using more than one or two methods of evaluating catching concurrently. Kelly et al. (1989) used qualitative procedures to measure changes in catching performance in pre-
school children whilst Broadhead and Church (1985) used quantitative measures for the DIAL test to determine movement characteristics of pre-school children. Arguments could be made as to what extent quantitative measures tell us how well a child can catch. For example, what happens if the child fumbles the ball? Qualitative measures can tell us more accurately where improvement in the catching process is taking place providing that the instrument is sensitive to minor changes in skill acquisition. Due to the differences in assessing skill performance presented in the literature, this study will be adopting both functional responses and topographical features to measure skill performance and discuss to what extent these measures tell the researcher how efficient the subject is catching.

Effective teaching in physical education

In order to implement an effective motor development program during the intervention period it is important that this literature review highlight some important points that must be considered when teaching skills to young children. According to Siedentop et al. (1984) research on teacher effectiveness, over the past ten years, has improved to the point where some major findings which have implications for practice can be reported. The effective teacher shows concern for clarity, conveys enthusiasm, demonstrates flexibility, demonstrates task orientated behaviour, ensures student opportunities to learn criterion materials and provides academic and behavioural feedback. The characteristics of effective teaching are not specific to any style of teaching, however for this study the style adopted will be that similar to what Rosenshine (1979) has labelled as direct instruction.
During direct instruction a great deal of time is devoted to achieving learning goals (time on task, opportunity to respond). Metzler (1989) suggests that research in motor skill practice initially looked at time on task (time variables) but more recently research in physical education has discovered that the opportunity to respond (motor appropriate or criterion task trials) can also be a strong predictor toward achieving skill mastery. Metzler's review of research on time in physical education suggests that although much more information needs to be gathered about the relationship of student functional time variables and achievement, "at least 11 studies completed report moderate to strong correlations between some construct of students' functional time and increased learning" (p. 95).

Teachers adopting the direct instruction strategy tend to control the flow of the lesson with fairly narrow questions and instructions (clarity). Academic and behavioural feedback is frequent and predominantly positive. Goals are clear and known to the students. The teacher, within this setting, is warm, friendly, and supportive (demonstrating enthusiasm and providing positive feedback etc). Teachers monitor and supervise students' work closely so as to keep students on task. Taggart (1985) has applied the principles of direct instruction to the development of fitness skills and the same or similar strategies appear appropriate for the refinement of the fundamental motor skill of catching.
Literature related to proposed methodology

The multiple baseline design

The multiple baseline design technique has become the most widely used tactic for experimental design in applied behaviour analysis. It is a highly flexible technique that enables a researcher or practitioner to analyse the effects of an independent variable across multiple behaviours, settings, and/or subjects without the necessity of withdrawing the treatment variable in order to reverse improvements in behaviour (Copper, Heron and Heward 1987, p. 195).

This research will adopt the multiple baseline across subjects design. Gay (1990, p. 306) suggests that when researchers apply treatments across subjects it is important to ensure that the subjects be as similar as possible, and the experimental setting be as identical as possible for each subject.

In the multiple baseline across subjects design, one target behaviour is selected for two or more subjects in the same setting. After steady state responding has been achieved under baseline conditions, the independent variable is applied to one of the subjects while baseline conditions remain in effect for the other subjects. When criterion level or stable responding has been attained for the first subject, the independent variable is applied to the second subject, and so on (Gay 1990, p. 306).
The multiple baseline across subjects design is the most widely used of all three forms of the design, in part because teachers, clinicians, and other practitioners are commonly confronted by more than one student or client needing to learn the same skill.

(Copper et al. 1987, p. 204)

This study will adopt the multiple baseline across subjects design and will include a slight variation to the design. This variation to the design will be the multiple probe design. The multiple probe design enables the teacher/behaviour analyst to extend the operation and logic of the multiple baseline tactic to behaviours or situations in which the concurrent measurement of all behaviours comprising the design is unnecessary, potentially reactive or impractical. In contrast to the multiple baseline design - in which data are collected throughout the baseline phase for each behaviour, setting, or subject in the experiment - in the multiple probe design intermittent measurements, or probes, provide the basis for determining whether behaviour change has occurred prior to intervention.

Copper et al. (1987) suggest that "although in practice the multiple probe design takes a variety of forms, the basic design has three key features"(p. 210). The features include an initial probe to determine the subject's level of performance, a series of repeated baseline measures is taken on each step prior to training on that step and then after criterion level performance is reached on any training step, a probe of each step in the sequence is taken to determine whether performance changes have occurred in any other steps. Appendix 1 displays an example of how the data is displayed using the multiple probe design.
Allison and Ayllon (1980) used a multiple baseline across subjects design to assess behavioural coaching in the development of skills in football, gymnastics and tennis. However, little research, if any, has used the multiple probe design in measuring the effects of motor skill instruction on young children.

**Summary of literature review**

This literature review has endeavoured to identify the variables that need to be considered when planning an intervention study designed to improve catching skill efficiency in pre-primary children. The literature has indicated that gross motor development is a crucial part of a child's overall development and sets the foundation for the development of more specific task-related motor skills that are an integral part of motor performance at all age levels.

Research that has investigated the effects of motor development programs on pre-primary children has shown that they have all proved successful in further developing fundamental motor skills. Perhaps the most interesting finding from these programs, is that the fundamental motor skill which displays the greatest improvement from simple instruction and practice is catching. Past research indicates that two important factors need to be considered when planning an intervention program designed to improve catching with young children. Allowing enough time for skill changes and ensuring that the instrument that measures changes in skill efficiency is sensitive to minor changes, appear to be crucial elements in the implementation and monitoring of an intervention program to improve catching skills.
Research into catching indicates that by the age of five years young children enhance the necessary skills to catch a ball in their hands or with other body parts. However, many variables involved in the catching process interact to make hand catching a very difficult task for young children. These variables may include the size of the ball, the distance the ball travels, the method of projecting the ball, visual perception cues, the direction of the ball whilst in flight, and the speed of the ball.

Other than the variables that affect the catching process, Starkes (1986) states that,

the subject variables which have been examined most often in relation to catching are chronological age, ability and/or experience in ball sports, sex, simple reaction time, and depth perception. (p.1275)

It is apparent that relatively little is actually known about many of the interactive factors involved in catching behaviour. In fact, the more difficult aspects of catching performance have scarcely been studied and as Wickstrom (1983, p. 143) clearly describes, have hardly been identified by many researchers. Most studies have examined each of these variables independently, and so knowledge of these variables has been gathered across studies.

The review of effective teaching in physical education indicates that young children need time on task and the opportunity to be motor engaged with the subject matter if improvements in skill are desired. The teacher during the intervention periods needs to set goals that are obtainable and clearly understood, show concern for clarity, convey enthusiasm, demonstrate flexibility, demonstrate task orientated behaviour and provide
academic and behavioural feedback. The characteristics of effective teaching noted in the literature are not specific to any style of teaching but the teaching model which appears to be most suitable for improving skill efficiency in young children is the direct instruction approach.

The review of literature has also alluded to some of the methodological considerations relevant to this study. The multiple probe design will be implemented because it is a highly flexible technique that enables a researcher to analyse the effects of an independent variable across subjects. It has been suggested that when implementing the multiple probe design across subjects, similar subjects should be selected and the experimental setting should be as identical as possible. Although the multiple probe design is common amongst behaviour analysis studies there has been very little research completed using the multiple probe design in measuring the effects of motor skill instruction on young children.

The most recent research reviewed (Walkley et al., 1993) highlights the importance of motor development programs and the current lack of competence by Australian primary children to execute fundamental motor skills beyond the mature level. Such findings carry important implications for the format, content, scope and sequence of physical education programs. Much careful research remains to be completed in the area of catching and the effects of direct instruction programs on pre-primary children.
Research Questions

The following research questions will be addressed in the study:

1. What effect does a 3 X 20 minute / week instructional motor development program have on the catching performance of selected pre-primary children?
   a) What topographical changes in the skill of catching occur as a result of the program?
   b) What functional changes in the skill of catching occur as a result of the program?
   c) What is the relationship between topographical changes and functional changes in the skill of catching?

2. How much instruction is needed to bring about changes in the catching performance of high and low skilled catching performers?
   a) How much instruction is needed to bring about changes in the catching performance of high gross motor performers?
   b) How much instruction is needed to bring about changes in the catching performance of low gross motor performers?

Limitations of the study

The major limitations of this study are that the intervention was specific, it occurred in a controlled environment and only the skill of catching was researched. With single subject research it is impossible to generalise the findings to other children and skill areas.
METHOD

Multiple probe design.

The multiple probe across subjects design was implemented to measure the effects of the independent variable (catching intervention) on the dependent variable (topographical and functional scores). All subjects were tested prior to the six week intervention period so that a decision could be made as to which subject had the most stable baseline. Unless skill levels were declining, the intervention commenced when a stable baseline was recorded. This typically required a series of three observations/assessments. Once a subject began the intervention period, probes were taken on the other subjects. This design attempted to reduce training effects during the testing period for those subjects not participating in the intervention. The test itself was a form of intervention.

Triweekly assessments took place on subjects in the intervention phase using the observation checklist and the catching task. The intervention occurred over a six week period. The independent variable was the motor program developed to increase catching skill performance and has been documented in Appendix 2. As well as documenting the catching program all sessions were video recorded so that the opportunities to respond and the dependent variable could be measured accurately.
Selection of subjects

The subjects for this study were selected from the population of pre-primary children at a suburban primary school in Perth. Towards the end of third term two sub-groups of high and low gross motor performers were determined from the teacher’s class records of the children’s gross motor development. Most pre-primary teachers’ records are not specific to the skill of catching, but consist of a checklist of gross motor skills that can be performed at a satisfactory or unsatisfactory level. These records will generally inform the researcher that the selected children demonstrate high or low levels of gross motor skills. Within each group two subjects were randomly chosen (drawing names from a bag). An additional child from each category was also chosen in case one of the selected subjects became sick or moved to another school. The final sample consisted of two high skilled and two low skilled performers in gross motor development.

Description of instruments

Two types of instruments were used to collect data on each subject. These instruments are referred to as the ball catching task and the topographical checklist. The ball catching task (Appendix 3) was chosen as a measure of catching performance because of the controlled way in which the test can be administered and the accuracy of its results.

Data from this test was quantitatively expressed and displayed improvement or deterioration of performance. However the weakness of this test was that it neglected to emphasize the process or the continual refinement of motor skill development.
The second instrument ( Appendix 4) was an observational/topographical checklist whereby critical elements of the skill were evaluated. The critical elements that were checked were:

**Readiness phase - head / trunk / arms.**

A. - semi flexed elbows pointing downward (e.g greater than 90 degrees) and at sides.

**Readiness phase - hands.**

B. - hands adjust to the level / fingers point in direction of oncoming ball

**Action Phase**

C. - hands contact the ball in unison.

D. - the ball is retained with the hands only.

E. - eyes follow the flight of the ball until contact with hands

F. - elbows flex to absorb force.

This type of data collection helped identify areas in catching performance which may have needed remediation or extension in the motor program. The strength of the checklist was that if a child dropped a catch during a performance it did not necessarily mean that the child scored zero for performance. The child might have received a high score because it was only the last part of the performance that failed, for example, hands retain the ball. Many of the crucial critical elements may have been present prior to the ball being
dropped. Another major strength of this tool was that it can monitor whether improvement in catching performance was attributed to better technique.

**Test one: Ball catching task**

The ball catching task was designed to measure the quantitative / functional aspects of the catching performance of pre-primary children. It is the most common type of testing used to measure a child's catching performance. The children were asked to catch two balls of approximately 18cm (medium) and 9cm (small) in diameter thrown towards him/her by the instructor from distances of three and five metres.

**Validity**

Validity of this instrument was tested on a different sample of children prior to the commencement of this study. Face validity of this instrument is assumed as it clearly measures the skill of catching.

**Reliability**

Reliability was assumed to be high given the controlled nature of this test, but again a series of pre-tests on another sample determined the inter- and intra- reliability of this instrument. It was vital that the instructor kept the trajectory of the ball constant throughout each trial to maintain any type of reliability. The instructor/researcher practised the skill prior to testing to ensure consistent trajectory.
Administration

The instrument was individually administered and took approximately five minutes to complete. No training requirements were needed for using the instrument. The following diagram illustrates the working area required to administer the instrument.

3M 5M (Floor markings)

[X]  [X]  [X]

Subject position  Instructor position  Instructor position

Figure 2. Floor markings for the administration of the ball catching task.

Scoring

The scoring of the ball catching task was one point for each ball caught. Appendix 5 displays how the data was recorded.

Test two: Topographical checklist

The topographical checklist was used to assess which critical elements were present in each performance and those which were not. The type of observation instrument used was adapted from Siedentop, Herkowitz and Rink (1984, p. 36) with alterations to the setting and the elements listed. Adjustments to the original format by Siedentop et al. (1984)
made the assessment procedure much more accurate in identifying strengths and weaknesses in the catching process while sensitive to minor changes in skill efficiency.

**Validity**

Validity of this instrument was pre-tested on children who were in different stages of catching development. The instrument identified the critical elements in each catching performance of mature and immature catchers.

**Reliability**

Reliability of this observational instrument depended on three factors. The first factor is intraobserver agreement where the observer makes two observations of the same behaviour on different days and then compares the results to see if the original observations were as accurate or different as the second. This was completed using a videotape of different performances.

The second factor is the interobserver agreement, when a different person observes the same behaviours and then results are compared to find a percentage of agreement.

In both instances calculating these percentages was completed by tallying the total number of critical elements present in each performance. For example:
The final reliability issue that needed to be addressed, was observer bias towards individual performance. By clearly stating the criteria of each category and video taping each performance so the catching performance may be viewed repeatedly, the observer was forced to make a decision as to which category the observed behaviour should be recorded.

Administration
Administration of the instrument required preparation of a video recorder, so that performance could be accurately recorded. In order to record the information gathered accurately from each performance it was crucial that the video recorder was set up in a position so that all critical elements in the skill could be assessed. As a result of field testing, the camera was positioned off centre (45 degrees) to the performer.
Intervention Program

The intervention program consisted of a number of prepared lesson plans based on improving catching performance (See Appendix 2).

The instructional model adopted was consistent with Rosenshine's (1979) direct instruction paradigm which describes the relationship between teacher behaviours, teaching activities, and student achievement. Although Rosenshine's original model was based on academic achievement, his proposed paradigm offered clear guidelines for those teachers who wish to make a difference to a child's skill level.

The following examples outline the teaching guidelines followed during the intervention.

Teaching activities

- Goals are clear to students.

Before the intervention began it was made clear to the children, through verbal instructions, that the aim of the program was to improve their catching performance.

- Sufficient time allocated for instruction.

When teaching young children it is important that enough time is allocated per week to make changes to skill efficiency but also remember that each instruction period can not be too long or else fatigue and/or lack of concentration may contribute to poor performance.

- Coverage of content is extensive.

Improving catching was the aim of the intervention and the activities chosen by the instructor were related to that area. Activities that involve the children catching different sized balls, catching from progressive distances and trajectory all aid the improvement of
catching. To improve catching, it is vital that the children have the opportunities to practice catching.

-Performance of students is monitored.

Continuous assessment took place so that any changes in skill efficiency could be diagnosed immediately. This was consistent with the multiple probe design. Assessments took place twice weekly prior to each intervention session. Reference to any changes in skill efficiency were clearly seen in the recorded data sheets. This data was then graphed session by session.

-Students can produce many correct responses.

The activities chosen by the teacher were designed so that some degree of skill mastery could be achieved by the children. Success at one level lead to further success at more difficult levels of the skill.

-Feedback to students is immediate and academic.

Knowledge of results and immediate feedback on performance was essential when teaching skill mastery. If feedback was not accurate and specific to the children then performance could have deteriorated.

Teacher's role:

-Controlling the instructional goals.

If instructors objectively assess the skill level of their children, then they should have the skills to determine specific skill areas that need improvement. For example, if a child
does not follow the flight of a ball with their eyes, then tracking activities may be appropriate to remedy this problem.

- Choosing materials appropriate for student abilities.

Just as skills should be progressively introduced, the physical activities should be designed to meet individual children's needs. For example, throwing a tennis ball from 10 metres away would not be very appropriate for a child learning to catch. More appropriately catching a beanbag from two metres might be a more suitable introduction to catching small objects.

- Pacing the instructional episode.

It is important that the teacher carefully introduces and further develops the skill so that motivation toward mastering the skill can be sustained.

- Allowing for repetition.

If skills are to be further developed it is important that the children are engaged with the subject matter a large proportion of the time so that repetition can lead to skilful catching.

**Motivation**

Variation of activities using different equipment made the intervention motivating and enjoyable for the children. For example, introducing different coloured balls, projectile ramps and rebound nets at different times throughout the intervention to pre-school children was very motivating. Using balloons in minor games added to a variation to practice with the balls.
Equipment

Within each lesson different types of equipment were utilised so that each child had maximum amount of success and practise time. The equipment included beanbags, swinging pendulums, rebound nets, different sized balls, projectile ramps, balls with different densities and balloons.

Materials/Apparatus

Special equipment required for this study included a video recorder, balls with diameters of approximately 18cm, 9cm, rebound nets and projectile ramps. The diagram below displays where the video recorder was situated during intervention sessions.

![Diagram of camera position](image)

**Figure 3.** Illustration of camera position throughout the intervention program.

Achieving baseline

Each subject performed the ball catching task a number of times so that baseline behaviour could be recorded. These data were then presented as a score out of five for each ball and for each distance. At the same time video observations of the same task were recorded and an observation checklist of the critical elements of the skill was
undertaken. These were then presented as the total number of critical elements present and recorded to measure changes in technique. When a child demonstrated steady baseline behaviour, or constantly scored the same for the catching task in both qualitative and quantitative measures then a decision was made to begin intervention.

**Intervention**

Intervention occurred three times a week for a period of 20 minutes over a six week period. The researcher was the instructor. Individual baselines that were either steady or declining, determined who was the next subject to begin the intervention. Instead of continuously assessing the subjects not participating in the intervention, probes were taken on the other subjects so that training in the testing period was reduced. The second, third, fourth, fifth and sixth subjects received less instruction than the first subject according to when they began the intervention program. For example, the last subject to begin intervention, who may be held in baseline for five weeks to strengthen the value of the independent variable, may only receive two weeks of instruction. This schedule is represented in the following diagram.
Figure 4: The multiple probe design schedule.

Scheduling the intervention time

The intervention took place during the normal movement program that the pre-primary teacher scheduled. Whilst the other children participated in their normal 40 minute outdoor activity session, the experimental group began their lesson by all completing the catching task. The session was videotaped. This routine continued for the six week period. Assessment data points were collected three times a week.

Once the subjects completed their catching task at the beginning of the session, all returned to the normal outdoor activities lesson whilst only those who had begun the treatment remained for twenty minutes. When the twenty minutes was complete, each
subject returned to their normal program to interact with their peers. This meant that the treatment group did not receive extra instruction but merely a different type of instruction. For example, when the normal outdoor activity time occurred with the pre-primary teacher the children had supervised play, but the treatment group received skill instruction. An indoor area attached to the main centre prevented wet weather hindering data collection.

**Intervention lesson plans.**

The intervention was based on documented lesson plans consisting of a variety of catching activities designed to increase skill performance. The types of activities included catching a swinging beanbag, catching different sized bounced balls, catching balls returned off a rebound net, projectile ramps and simple minor games involving different types of balls. A circuit type design with different working stations was adopted when more than one subject participated in the lessons. This process was continued for the term with three subjects participating in the intervention.

**Video recording.**

During the intervention sessions a video recorder was set up in the room to record activities in the entire working area thus monitoring the type of instruction and feedback given to each child. The videotape enabled analysis of the successful catches each child completed during the lessons.
Testing procedure- Instrument one / Catching task

The subjects were required to take their shoes off before completing the catching task. The series of trials started with a medium sized ball (approx. 18cm diameter), followed by a smaller sized ball (approx. 9cm diameter). With the medium sized ball, the teacher stood three metres from the subject and gave the child one practice catch. According to Belka (1985) one practice catch warm up before each new distance would not affect the results of the experimental trials that followed.

On the verbal cue "ready" the teacher lobbed the ball toward the subject in an underarm style so that the child made no body adjustment. The trajectory of this lob was approximately 157cm and 187cm in height at three and five metres respectively.

The thrower's responsibilities was to (a) help the child be at ease while concentrating fully on the task, (b) release the ball at the same height as the target receiving height with only a slight aerial arc pattern, (c) keep the child highly task motivated but not give any specific verbal feedback relevant to the task.

At three metres the child attempted to catch five underarm throws. Completing the test at three metres the same procedure was applied at five metres.

This concluded the test with the medium sized ball. Using the small ball, the procedure was then repeated.

Testing Summary:

* From the three metre mark the subject received one practice catch.

* On the verbal cue "ready" the instructor lobbed the ball directly toward the subject.
* Once the subject had a practice catch, the test began.

* The test included five throws directly toward the subject requiring no excessive foot movement.

* One point was recorded for each time the ball was successfully retained in the hands for three seconds.

* The same procedure occurred for five metres and with the small ball.

If the trajectory of a throw was inconsistent with other throws (bad throw), then that throw was not included in the data analysis and another throw was completed.

**Testing procedure- Instrument two / Observational instrument**

A series of catching performances was videotaped and analysed using the observation instrument to assess where inefficient elements may be occurring. This checklist was useful in monitoring the motor program and whether the children were becoming trained in the catching assessment task.

Performances with each ball from each distance were analysed using slow motion on the video to record those critical elements present during performance. Data were then displayed as a score out of six for the number of critical elements present. Appendix 4 displays the topographical checklist that was implemented.
Data Analysis and Interpretation

Catching task

All data collected from the catching task is presented in graphical form so that evidence of functional relationships can be established. The data is presented in this form so that the effect of the treatment can be clearly seen.

Observational instrument - Topographical checklist

The video recordings of all performances at each distance were analysed using the topographical checklist so that a score out of six could be given to those critical elements present.

Methodological limitations to the study

A major limitation to the study is the way in which the video recording will assess the critical elements present in each catching performance. More sophisticated video equipment would be able to detect minor changes in skill efficiency than the equipment used. This would have meant that the topographical checklist used would have had more categories and be more sensitive to minor changes in the catching ability of the children. However, one of the aims of this project was to remain as close to the real pre-primary setting as possible and not complete another laboratory type investigation that may not be relevant to the "normal teacher" teaching pre-primary children. Given the applied nature of this study all observations and assessment have been designed so that any interested teacher could apply the same type of testing to their own pre-primary setting.
RESULTS

The following chapter will present the results recorded throughout the intervention by discussing individual subject’s functional and topographical scores at three and five metres with a small and medium sized ball. The results are presented in table and graphical forms and clearly show the idiosyncratic nature of each child’s development in the skill of catching.

Subject A: Melanie

Melanie was a quiet, shy girl who approached the intervention with enthusiasm and enjoyed the challenge of improving her catching ability. Field notes recorded throughout the intervention did not record any indication of negative behaviour towards the intervention program. The teachers records identified Melanie as a high gross motor performer. For further detail on field notes recorded throughout the study refer to Appendix 6.

Melanie began the intervention in week three of the study. A short time after the intervention, the subject became anxious with what she perceived as failure during the assessment process. To decrease anxiety, the researcher decided to alter the research design so that fewer probes were taken and the subject was not assessed on each intervention lesson. Melanie was assessed on alternate intervention sessions and less frequent assessments were made. As the study progressed, and the other subjects joined the intervention program, field notes observations suggested that Melanie became less anxious.
Melanie's functional scores with a small ball at three and five metres.

Table 2 and Figure 5 display Melanie's functional scores for catching a small ball over a distance of three and five metres during the study.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<tr>
<td>2</td>
<td>1.0</td>
<td>2.0</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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<tr>
<td>Intervention Mean</td>
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<td>0.4</td>
</tr>
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</table>

Table 2.

Melanie's functional scores for catching a small ball at three and five metres.

**Baseline**

Assessment point one at three metres indicates that two catches were made followed by one at data points two and three respectively. At assessment point four an increase in successful catching occurred with two catches being made.
Figure 5. Melanie's functional scores for catching a small ball at three and five metres.

The first and second assessment point at five metres indicates that two catches were made followed by no successful catches at assessment points three and four. The decision to intervene was made after assessment point three on the basis that the data indicated that the target behaviour appeared to have decreased and was stable. Intervention did not commence until after the fourth session as assessment began at the start of each lesson. Table 2 indicates that Melanie displayed a baseline mean of 1.5 at three metres and a baseline mean of 1.0 from five metres with a small ball.

**Intervention**

Immediately after intervention an increase in successful catching at three metres was evident. At five metres the number of successful catches increased to one catch. Following
an initial increase, the number of successful catches tended to fluctuate on different assessment days. At three metres scores ranged between one and three catches whilst at five metres scores ranged between one and no successful catches. Table 2 indicates that Melanie had a mean functional score of 2.7 at three metres and a mean of 0.4 at five metres following intervention.

Discussion

The results indicate that catching at three metres with a small ball displayed an improvement in functional scores following intervention. At the distance of five metres a decrease in functional scores with a small ball was recorded. Figure 6 displays an improvement at three metres and the decrease in the number of catches at five metres as a result of the independent variable being implemented. Melanie's results are in accordance with the previous research by Ridenour (1977) and Warner's study (in Wickstrom 1983, p. 138) concluding that in general, balls moving a shorter distance were intercepted more frequently than balls moving a longer distance. The results also demonstrate that as ball size decreases, the ability to track a small moving object becomes increasingly more difficult. Both Morris (1980) and Herkowitz (1978) indicate that young children find hand catching small balls very difficult, with medium sized balls being the easiest to catch.
Figure 6. Melanie's mean functional results with a small ball at three and five metres during baseline and intervention.

Figure 5 also illustrates similar trends between functional scores at three metres and five metres. When assessments were made on the same day, similar scores resulted. Improved functional performance at three metres was generally followed by improved performance at five metres. Consistent with the data collected and the literature reviewed Melanie showed that at shorter distances small balls can be intercepted more successfully than over greater distances.

Melanie's functional scores with a medium sized ball at three and five metres.

Table 3 and Figure 7 display Melanie's functional scores for catching a medium sized ball over a distance of three and five metres during the study.
### Table 3. Melanie's functional scores for catching a medium-sized ball at three and five metres.

<table>
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<th>Five metres</th>
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<tbody>
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<td>Baseline Mean</td>
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<tr>
<td>5</td>
<td>4.0</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
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<td>1.0</td>
</tr>
<tr>
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</tr>
<tr>
<td>9</td>
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<td>0</td>
</tr>
<tr>
<td>10</td>
<td>4.0</td>
<td>1.0</td>
</tr>
<tr>
<td>11</td>
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<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>15</td>
<td>5.0</td>
<td>0</td>
</tr>
<tr>
<td>Intervention Mean</td>
<td>3.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Baseline**

At both three and five metres baseline behaviour appeared to be relatively stable. At three metres the first assessment point recorded two successful catches which was followed by scores of three, one and two at assessment points two, three and four respectively. At five metres the first assessment point recorded no successful catches which then increased to one at assessment points two and three and at assessment point...
four, no successful catches were recorded. Table 3 indicates that Melanie displayed a baseline mean of 2.0 at three metres and a baseline mean of 0.5 at five metres.

**Figure 7.** Melanie's functional scores with a medium sized ball at three and five metres.

**Intervention**

Following intervention functional scores at three metres initially decreased steadily over assessment points five to nine to reach a low of no score at assessment point nine. An increase in scores then occurred at assessment point ten and highest scores of five successful catches were recorded on two occasions at assessment points eleven and twelve. At five metres, scores fluctuated and no sign of improvement was evident. Scores ranged between one successful catch to no successful catches. Table 3 indicates
that following intervention the mean baseline behaviour for three metres was 3.4 and 0.5 for five metres with a medium sized ball.

**Discussion**

The results indicate that catching at three metres with a medium sized ball displayed an improvement in functional scores following intervention. Mean functional scores remained stable from a distance of five metres. Figure 8 displays the improvement at three metres as a result of the intervention program and the absence of improvement over five metres.

![Figure 8. Melanie's mean functional results with a medium sized ball at three and five metres during baseline and intervention.](image-url)
The mean score of 3.4 and 0.5 at three and five metres respectively are consistent with the research reviewed earlier, whereby Ridenour's (1977) study concluded that in general, balls moving a shorter distance were intercepted more frequently than balls moving a larger distance. When the mean scores of the small ball and medium sized balls are compared at both distances after intervention, it is interesting to note that at both distances with the medium sized ball, Melanie scored a higher mean than catching the smaller ball. Payne (1981) concluded that 10 inch diameter balls resulted in significant superior catching performance than balls with a 6 inch diameter. Both Morris (1980) and Herkowitz (1978) support this view by stating that balls of medium size are easiest to catch, with larger balls more difficult and smaller balls most difficult. Interestingly the findings from this study are consistent with that reviewed in the literature.

<table>
<thead>
<tr>
<th>Small Ball</th>
<th>Medium Ball</th>
</tr>
</thead>
<tbody>
<tr>
<td>3m X = 2.7</td>
<td>X = 3.4</td>
</tr>
<tr>
<td>5m X = 0.4</td>
<td>X = 0.5</td>
</tr>
</tbody>
</table>

Table 4
Comparison of functional mean scores with a small and medium sized ball at three and five metres following intervention.
Melanie's topographical mean scores with a small ball at three and five metres.

Table 5 and Figure 9 display Melanie's topographical mean scores with a small ball over a distance of three and five metres during the study.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.8</td>
<td>3.6</td>
</tr>
<tr>
<td>2</td>
<td>2.6</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>2.8</td>
<td>1.2</td>
</tr>
<tr>
<td>4</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Baseline Mean</td>
<td>2.8</td>
<td>2.0</td>
</tr>
<tr>
<td>5</td>
<td>4.0</td>
<td>3.6</td>
</tr>
<tr>
<td>6</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>7</td>
<td>3.6</td>
<td>1.8</td>
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<tr>
<td>8</td>
<td>3.2</td>
<td>2.0</td>
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<tr>
<td>9</td>
<td>4.0</td>
<td>2.8</td>
</tr>
<tr>
<td>10</td>
<td>4.6</td>
<td>4.0</td>
</tr>
<tr>
<td>11</td>
<td>3.8</td>
<td>3.6</td>
</tr>
<tr>
<td>12</td>
<td>4.0</td>
<td>3.4</td>
</tr>
<tr>
<td>13</td>
<td>2.8</td>
<td>2.4</td>
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<td>2.2</td>
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<tr>
<td>15</td>
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<td>3.0</td>
</tr>
<tr>
<td>Intervention Mean</td>
<td>3.8</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Table 5

Melanie's topographical mean scores with a small ball at three and five metres.

Baseline

At three metres mean topographical data remained stable, with scores ranging between 2.8 and 3.0. At five metres, assessment point one recorded a mean topographical score of 3.6 which then decreased to lower levels in sessions two, three and four. Table 5
indicates that Melanie displayed a baseline mean of 2.8 at three metres and a baseline mean of 2.0 from five metres.

Figure 9. Melanie's mean topographical results with a small ball at three and five metres.

**Intervention**

Following intervention a trend between topographical mean scores indicated at three and five metres occurred. When assessments were made on the same day similar scores resulted. Improved topographical performance at three metres was followed by improved performance at five metres although with decreased performance at the greater distance. Table 5 indicates that following intervention the mean topographical results recorded were 3.8 at three metres and 3.0 at five metres.
**Intervention Lessons**

Melanie participated in 11 intervention lessons and was assessed on 15 occasions. The topographical checklists of Melanie’s catching ability with a small ball revealed that Melanie had difficulty making simultaneous contact with the ball and retaining the ball with only the hands. As the study progressed these two critical elements occurred more frequently in each catching session. Further analysis of the topography of Melanie’s catching also revealed that she frequently kept her eyes on the ball and adjusted her hands to the level of the ball. From the data collected on the topography of Melanie’s catching ability, lessons were designed to help Melanie make simultaneous hand contact with the ball and to retain the ball in the hands only by flexing her elbows. Activities involving a rebound net and a swinging bean bag incorporated with other catching activities were implemented to overcome these problems. As a result of addressing these problems more critical elements became evident in Melanie’s catching ability and improvements were recorded.

**Discussion**

The results indicate that catching at three and five metres with a small ball displayed an improvement in mean topographical scores following intervention. Figure 10 displays the improvement that has occurred at three and five metres as a result of the independent variable being implemented.
Figure 10. Melanie's mean topographical results with a small ball at three and five metres during baseline and intervention.

Isaacs (1980) indicates that small balls encourage mature catching patterns. In the assessment of mature catching, one of the critical elements is hand catching or retaining the ball with the hands only. By using bigger balls, it is very difficult for young children to hand catch, tending instead to trap the ball against their chest. With a smaller ball Melanie's catching behaviour has improved topographically although functionally the results decreased at a distance of five metres. At three metres an improvement in topographical scores also resulted in improved functional results. Using the smaller ball during the intervention program has encouraged her to demonstrate mature catching patterns at both three and five metres.
Melanie's mean topographical scores with a medium sized ball at three and five metres.

Table 6 and Figure 11 display Melanie's mean topographical results with a medium sized ball at three and five metres during the study.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>2.6</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td>4</td>
<td>1.8</td>
<td>1.6</td>
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<tr>
<td>Baseline Mean</td>
<td>1.6</td>
<td>1.2</td>
</tr>
<tr>
<td>5</td>
<td>3.0</td>
<td>2.4</td>
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<td>6</td>
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<td>15</td>
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<td>2.8</td>
</tr>
<tr>
<td>Intervention Mean</td>
<td>4.0</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Table 6
Melanie's mean topographical results with a medium sized ball at three and five metres.

Baseline

Baseline data at both three and five metres prior to intervention remained stable. At three metres the baseline data were initially variable but then stabilised at assessment points three and four. At five metres the data displayed a gradual improvement between the first three assessment points then also stabilised at points three and four. Table 6
indicates that Melanie displayed a baseline mean of 1.6 at three metres and 1.2 at five metres with a medium sized ball.

Figure 11. Melanie's mean topographical results with a medium sized ball at three and five metres.

Intervention

Following intervention an increase in scores is clearly seen in figure 11. Results at three metres remained relatively high with a decrease in scores only at assessment point nine. At five metres the data fluctuated between mean scores of two and four. Table 6 indicates that Melanie displayed a mean topographical score at three metres of 4.0 and 2.7 at five metres following intervention.
**Intervention Lessons**

Melanie participated in 11 intervention lessons and was assessed on 15 occasions. Topographical checklists of Melanie’s catching ability with a medium sized ball revealed that Melanie had difficulty retaining the ball with only the hands and was not flexing her elbows on impact which contributed to the ball bobbing out of the hands on impact. As the study progressed these two critical elements were identified as the major reasons for why functional scores were low. Further analysis of the topography of Melanie’s catching also revealed that during the catching process she started with flexed elbows, adjusted her hands to the level of the oncoming ball and kept her eyes on the ball. From the data collected on the topography of Melanie’s catching ability, lessons were designed to help Melanie give with the ball on contact by flexing the elbows so that the ball could be more easily retained. Activities involving a rebound net and a swinging bean bag incorporated with other catching activities were implemented to overcome this problem. The topographical checklist indicated that during the intervention changes to this critical element did not occur.

**Discussion**

The results indicate that catching at three metres and five metres displayed an improvement in mean topographical scores following intervention. Figure 12 displays Melanie's progress during the intervention program and clearly displays the strength of the independent variable being implemented.
The results indicate an improvement in catching at both three and five metres with the greatest improvement being at three metres. Although Wickstrom (1983) and Isaacs (1980) indicate that smaller balls encourage hand catching there appears to be greater improvement with the medium sized ball than the smaller tennis ball.

An explanation for why catching the medium sized ball displays greater improvement than the smaller sized ball may be that the medium ball (6 inch diameter) is still big enough for children of this age to catch in their hands with simultaneous hand contact. A smaller ball requires almost precise simultaneous hand contact with both hands. If simultaneous contact does not occur with a small ball then the ball is more than likely going to be bobbled or trapped against the chest. A big ball (approx.10") does not encourage any type of hand catching because the ball is too big to be controlled by the
hands which then causes young children to naturally trap the ball against their chest, thus avoiding in most instances hand contact. Indeed both Morris (1980) and Herkowitz (1978) share the same view that medium sized balls are easiest for young children to hand catch. When the mean topographical scores of the small ball and medium sized balls are compared at both distances following intervention, the medium sized ball has a higher mean than the smaller ball at three metres and both balls at five metres displayed similar scores.

Summary of Results

Tables 7 and 8 summarise the results of Melanie's catching ability at three and five metres using both functional and topographical measuring devices.

<table>
<thead>
<tr>
<th>Ball Size</th>
<th>Small</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Intervention</td>
</tr>
<tr>
<td>3M</td>
<td>1.5</td>
<td>2.7</td>
</tr>
<tr>
<td>5M</td>
<td>1.0</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 7

Summary of Melanie's mean functional results for a small and medium ball at three and five metres.
Table 8

Summary of Melanie’s mean topographical results for a small and medium ball at three and five metres.

Small Ball

Melanie’s results indicate that at three metres with a small ball an improvement in functional and topographical scores occurred as a result of the intervention program. At five metres no improvement occurred functionally although an improvement in the topography of the skill was recorded.

Medium Ball

The greatest improvement both functionally and topographically was with the medium sized ball. At three metres both functional and topographical measures of the skill displayed an improvement with the greatest being in the topography of the skill. From the distance of five metres a small improvement occurred functionally with the greatest improvement being again in the topography of the skill.

It is important to note that only at five metres, with a small ball, did a decrease in the number of successful catches occur as a result of the intervention. Although a decrease
in functional results was recorded throughout the instructional period, an improvement in
the topography of the skill was also recorded. This indicates that although the child may
not have made as many successful catches from five metres with a small ball, the
topography of their skill had improved. The importance of individual data based on
repeated measures is clearly emphasized here. Knowing a lot about one subject appears
to be crucial in developing student profiles of fundamental motor skills.

Subject B: Caitlin

Caitlin was a very quiet girl who thoroughly enjoyed participating in the intervention
program. Field notes indicated that Caitlin had a short concentration span and found it
difficult to remain on task towards the end of assessment sessions. Caitlin was easily
distracted during the intervention lessons. For further detail on field notes recorded
throughout the study refer to Appendix 6. Prior to the intervention study, according to the
pre-primary teacher's records, Caitlin was identified as a low gross motor performer.

Caitlin's functional scores with a small ball at three and five metres.

Table 9 and Figure 13 display Caitlin's functional scores for catching a small ball over a
distance of three and five metres during the study.
Baseline

Baseline behaviour at three metres was unstable with functional scores ranging from one to three successful catches. Prior to intervention, scores remained at one successful catch. At five metres scores ranged from zero to one successful catch. Before intervention functional scores were recorded at zero. Table 9 indicates that when catching a small ball Caitlin displayed a baseline mean of 1.4 at three metres and 0.4 at five metres.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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</tr>
<tr>
<td>2.</td>
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</tr>
<tr>
<td>3.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Baseline Mean</td>
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<td>0.4</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
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<tr>
<td>6.</td>
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<tr>
<td>7.</td>
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<td>8.</td>
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</tr>
<tr>
<td>Intervention Mean</td>
<td>2.3</td>
<td>1.7</td>
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</table>

Table 9.

Caitlin's functional scores for catching a small ball at three and five metres.
Intervention

Initially scores did not improve after the first intervention lesson. Following assessment point eleven, scores at three metres improved and ranged between two and four successful catches. At five metres, scores ranged between one and two successful catches. Following six twenty minute instructional sessions the mean functional score at three metres increased to 2.3 and at five metres a mean of 1.7 was recorded.

Discussion

The results indicate that catching a small ball at three and five metres displayed an improvement in functional scores following intervention. Figure 14 displays the improvement that has occurred at three and five metres as a result of the independent variable being implemented.
Caitlin's results clearly indicate that an improvement in functional scores at both three and five metres with a small ball occurred as a result of the intervention program. These results are consistent with the literature reviewed by Van de Mars & Butterfield (1987) and Kelly et al. (1989) who found that when an experimental group were exposed to sequentially arranged gross motor instructional activities the skill that showed the most improvement was catching. Caitlin has demonstrated that through quality instruction and practice her functional performance has improved. Caitlin's results also indicate that balls travelling greater distances are far more difficult to intercept than those travelling shorter distances. Warner's study (in Wickstrom 1983, p.138) found that at shorter distances small balls can be intercepted more frequently than over greater distances. Although Caitlin displayed a greater improvement in catching small balls at five metres, Caitlin caught more balls at three metres before and after intervention than at five metres.
Caitlin's functional scores with a medium sized ball at three and five metres.

Table 10 and Figure 15 display Caitlin's functional scores for catching a medium sized ball at three and five metres during the study.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<td>9</td>
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<tr>
<td>Intervention Mean</td>
<td>2.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 10

Caitlin's functional scores with a medium sized ball at three and five metres.
Baseline

Baseline data at five metres were stable whilst at three metres scores were variable. Scores at three metres ranged between two and five successful catches. At five metres scores were recorded at one and no successful catches. Table 10 indicates that Caitlin displayed a baseline mean of 3.2 at three metres, and 0.4 at five metres with a medium sized ball.

Intervention

Initially there were no improvements in catching at three metres until the second intervention lesson. An increase in functional scores at three metres occurred at assessment point 11 with scores ranging between two and four successful catches. At five metres the number of successful catches steadily improved until assessment point 14. The number of successful catches at five metres then declined to no successful catches recorded at

Figure 15. Caitlin's functional scores with a medium sized ball at three and five metres.
assessment point 15. Table 10 indicates that following intervention Caitlin recorded a mean of 2.5 at three metres and 0.5 at five metres.

Discussion

The results indicate that following intervention, catching at three metres displayed a decrease in functional scores. At the distance of five metres a slight improvement in functional scores was recorded. Figure 16 displays the decrease in scores at three metres as a result of the independent variable being implemented.

Figure 16. Caitlin's mean functional responses at three and five metres with a medium sized ball during baseline and intervention.

Caitlin's results are in accordance with some results discussed by Ridenour (1977), who concluded that in general balls moving a shorter distance were intercepted more frequently than balls moving a larger distance. It appears that at a shorter distance of three metres
Caitlin was able to catch the medium sized ball more frequently than over a distance of five metres.

Isaacs (1980) has eluded that larger balls tend to cause a fear reaction to many children which causes them to tilt their head back and take their eyes off the ball. Field notes recorded that Caitlin constantly turned her head away and took her eyes off the ball when using the medium sized ball over three and five metres. This characteristic alone could contribute to the fact that little progress was made functionally at three and five metres with a medium sized ball over the instructional period. The data presented shows that the instructional program had no lasting effect on the functional scores of Caitlin catching a medium sized ball at both three and five metres. The data also reinforces the variable nature of children's performance, particularly low skilled children.

Caitlin's topographical mean scores with a small ball at three and five metres.

Table 11 and Figure 17 display Caitlin's topographical mean scores with a small ball over a distance of three and five metres.

Baseline

At both three and five metres mean topographical results were initially variable with a similar pattern of results being displayed. At assessment points eight and nine results became more stable. Table 11 indicates that Caitlin displayed a baseline mean of 3.0 at three metres and 2.8 at five metres.
Table II

Caitlin's topographical mean score with a small ball at three and five metres.

**Intervention**

Following the first lesson a small improvement in topographical results occurred both at three and five metres with no dramatic changes in the number of critical elements present. A pattern in behaviour was noted at three and five metres. When performance at three metres increased or decreased, similar results occurred at five metres. This trend in the data suggests that performance was consistent from day to day. The mean topographical results were 3.4 at three metres and 2.7 at five metres following intervention.
Figure 17. Caitlin's mean topographical results with a small sized ball at three and five metres.

**Intervention Lessons**

Caitlin participated in 8 intervention lessons and was assessed on 11 occasions. The topographical checklists of Caitlin's catching ability with a small ball revealed that Caitlin had a fear reaction to the on-coming ball and kept turning her head away. This action caused Caitlin's eyes to be taken off the ball which then caused hand contact problems and retaining the ball in only the hands. Caitlin displayed an immature catching pattern and in most circumstances attempted to trap the ball with her arms. With a small ball this technique did not prove to be successful. By trapping the ball no score could be recorded for simultaneous hand contact, continuous eye contact and elbow flexing. As the study progressed, trapping the ball became less frequent which then
caused other critical elements to be more frequent. Further analysis of the topography of Caitlin's catching also revealed that she began the catching process with elbows flexed and moved her hands to the level of the ball correctly. From the data collected on the topography of Caitlin’s catching ability, lessons were then designed to help Caitlin overcome her fear reaction to balls and encourage her to hand catch instead of trapping. Activities involving balloon tapping with body parts, playing with a swinging beanbag and becoming more familiar with the properties of a ball were implemented to overcome these problems. As a result of the lessons implemented and the time available very little progress was made to overcome these problems.

Discussion

The results indicate that a slight improvement in mean topographical scores at three metres occurred following intervention. At five metres no improvement in the topography of the skill occurred. Figure 18 displays the limited effect of the independent variable on the topography of Caitlin's catching ability at three and five metres with a small ball. Caitlin's topographical results are consistent with the literature, where Ridenour (1977) found that when distance between the catcher and the thrower increases then the skill of catching becomes more difficult. Caitlin displayed an improvement in the topography of the catch from three metres but found the distance of five metres too difficult to make improvements in the technique of her catching.
Belka (1985) eludes to the fact that the speed/velocity factor of the ball from greater distances contributes to making catching a very difficult skill. Field notes recorded a fear reaction of the ball being thrown from five metres. A combination of distance and the velocity of the ball could have contributed to decreased performance. Whilst Caitlin was able to make adjustments to improve her catching at three metres, factors such as the distance and the speed/velocity factor obviously contributed to less success at five metres.

Mean topographical results with a small ball display a plateau of skill development throughout the intervention period. When this data is compared to functional scores at both three and five metres more highs and lows in performance are evident but there is little evidence of the development of the skill. The topographical data gives far more insight as
to the type of progress being made by the subject and the analysis of each catch gives exact information as to which critical elements were not present.

Caitlin's mean topographical scores with a medium sized ball at three and five metres.

Table 12 and Figure 19 display Caitlin's mean topographical results with a medium sized ball at three and five metres during the instructional program.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Intervention Mean</td>
<td>3.2</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Table 12

Caitlin's mean topographical scores with a medium sized ball at three and five metres.
Baseline

At three metres baseline scores appeared to display some improvement prior to the intervention lessons. At five metres baseline behaviour appeared to be relatively stable with a decrease in scores before intervention. Table 12 indicates that Caitlin displayed a baseline mean of 2.7 for three metres and 1.8 for five metres with a medium sized ball.

Figure 19. Caitlin's mean topographical scores at three and five metres with a medium sized ball.

Intervention

Following intervention there was a fluctuation in topographical scores at three metres but a steady improvement in mean topographical scores at five metres. Table 12 indicates that following intervention Caitlin displayed a mean topographical score of 3.2 at three metres and 2.4 at five metres.
Intervention Lessons

Caitlin participated in 8 intervention lessons and was assessed on 11 occasions. The topographical checklists of Caitlin's catching ability with a medium size ball revealed similar patterns recorded with the smaller tennis ball. Caitlin had a fear reaction to the on-coming ball and kept turning her head away. This action caused Caitlin's eyes to be taken off the ball which then caused hand contact problems and not retaining the ball in only the hands. Caitlin displayed an immature catching pattern and in most circumstances attempted to trap the ball with her arms. With a medium sized ball this technique proved to be more successful than the smaller ball because simultaneous hand contact was not crucial. Trapping the ball meant that no score could be recorded for simultaneous hand contact, continuous eye contact and elbow flexing. As the study progressed, trapping the ball became less frequent which then caused other critical elements to appear more frequently. Further analysis of the topography of Caitlin's catching also revealed that she began the catching process with elbows flexed and moved her hands to the level of the ball correctly. From the data collected on the topography of Caitlin's catching ability, lessons were then designed to help Caitlin overcome her fear reaction to balls and encourage her to hand catch instead of trapping. Similar activities were incorporated into the lessons from the results of the small ball. As a result of the lessons implemented and the time available very little progress was made to overcome these problems.
Discussion

The results indicate that the topography of Caitlin's catching improved marginally at three and five metres with a medium sized ball. Figure 20 displays the slight improvement in mean topographical scores during baseline and intervention at three and five metres with a medium sized ball.

Figure 20. Caitlin's mean topographical scores with a medium sized ball at three and five metres during baseline and intervention.

Caitlin's results indicate that as a result of the instructional program, the number of critical elements present during the act of catching has increased slightly at distances of three and five metres. Although an improvement in the number of critical elements was recorded as a result of the intervention, the mean number of critical elements recorded with a medium sized ball was lower than that of the smaller ball.
Summary of Results

Tables 13 and 14 summarise Caitlin's mean functional and topographical results at three and five metres using a small and medium sized ball.

<table>
<thead>
<tr>
<th>Ball Size:</th>
<th>Small</th>
<th>Medium</th>
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</thead>
<tbody>
<tr>
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<td>5M</td>
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</tbody>
</table>

Table 13

Summary of Caitlin's mean functional results with a small and medium sized ball at three and five metres.

<table>
<thead>
<tr>
<th>Ball Size:</th>
<th>Small</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Intervention</td>
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<td>3M</td>
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<tr>
<td>5M</td>
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</table>

Table 14

Summary of Caitlin's mean topographical results with a small and medium sized ball at three and five metres.

Small Ball

At three metres catching skill improved both functionally and topographically as a result of the intervention program. At five metres an increase in results occurred functionally which coincided with stable topographical scores. This would suggest that no improvements in
the technique of the skill at five metres took place although in functional terms an increase in the number of successful catches occurred.

**Medium Ball**

At three and five metres inconsistent results in functional scores were recorded. A decrease in functional scores at three metres occurred whilst scores at five metres remained relatively stable. Topographically, Caitlin's scores displayed an improvement at both three and five metres. These results would indicate that during the intervention program, Caitlin had increased the number of critical elements in her catching technique although the medium sized ball was not caught as frequently.

Caitlin's catching ability, with a small ball, improved both functionally and topographically with the small ball. With the medium sized ball functional scores appeared to vary whilst an improvement in the topography of the skill was recorded. The results also indicate that although the medium sized ball may have been caught more frequently at three metres than the smaller ball, it did not encourage more mature catching patterns than the smaller ball. It is important to note that although only small increases in scores resulted, Caitlin received only six lessons of instruction. Although there was minimal instruction, improvement was still recorded.
Subject C: Nicholas

Nicholas was an enthusiastic child who thoroughly enjoyed participating in the intervention program. He was always helpful and willing to learn. Nicholas always enjoyed communicating throughout the assessment and intervention lessons. Nicholas was the third child to participate in the intervention lessons and was identified as a low gross motor performer from the pre-primary teacher’s records. Due to the applied nature of this study and the everyday events that occur in a pre-primary school, Nicholas only participated in one intervention lesson.

Nicholas's functional scores with a small ball at three and five metres.

Table 15 and Figure 21 display Nicholas's functional scores for catching a small ball made over a distance of three and five metres during the study.

Baseline

Baseline behaviour at three metres was unstable with functional scores ranging from no successful catches to three successful catches. At five metres scores ranged from no catches to two successful catches. Table 15 indicates that Nicholas displayed a baseline mean of 1.4 at three metres and 0.8 at five metres.

Intervention

After intervening with one twenty minute instructional session, the functional scores at three metres increased to four successful catches whilst scores at five metres remained stable. Intervention lasted only one session due to unexpected events which impinged on
the timeline of the study. Refer to Appendix 6 for further details recorded during the intervention.

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<th>Assessment Point</th>
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<th>Five Metres</th>
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<td>15.</td>
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Table 15
Nicholas's functional scores for catching a small ball at three and five metres.

Discussion
The mean functional results indicate that catching at three metres displayed an improvement in the number of successful catches at assessment points fourteen and fifteen. At five metres no improvement was evident.
Nicholas's functional responses with a small ball at three and five metres.

Nicholas's functional scores with a medium sized ball at three and five metres.

Table 16 and Figure 22 display Nicholas's functional scores for catching a medium sized ball over a distance of three and five metres during the study.

**Baseline**

At three metres baseline scores ranged between two and four successful catches. At five metres scores ranged from five to no successful catches. Table 16 indicates that Nicholas displayed a baseline mean of 2.7 at three metres and 2.1 at five metres.

**Intervention**

Following one intervention lesson an increase in the number of successful catches was recorded. A decrease from three catches to one successful catch occurred at five metres following the intervention lesson.
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<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
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<tr>
<td>15</td>
<td>4.0</td>
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</table>

Table 16
Nicholas's functional scores for catching a medium sized ball at three and five metres.

Discussion
A slight improvement in the number of successful catches during the assessment periods occurred at three metres as the study progressed with scores at five metres displaying no pattern of improvement.
Figure 22. Nicholas's functional responses with a medium sized ball at three and five metres.

Nicholas's topographical mean scores with a small ball at three and five metres.

Table 17 and Figure 23 display Nicholas's topographical mean scores with a small ball over a distance of three and five metres during the study.

Baseline

At three metres mean topographical responses was relatively stable with scores ranging between 2.8 and 3.8. At five metres mean scores ranged between 1.4 and 3.4. Nicholas displayed a baseline mean of 3.1 at three metres and 2.4 at five metres with a small ball.
Table 17

Nicholas's topographical mean scores with a small ball at three and five metres

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
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<td>15</td>
<td>3.8</td>
<td>3.0</td>
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</table>

**Intervention**

Following one intervention lesson an increase in the number of mean topographical scores resulted at three metres and five metres.
Intervention lessons

Nicholas participated in one intervention lesson and was assessed on eight occasions. The topographical checklists of Nicholas's catching ability with a small ball revealed that Nicholas tended to contact the ball with both hands but then drew the ball onto his chest in a trapping action. The checklist also revealed that as the ball was contacted and drawn to his chest he turned his head away from the ball. Nicholas displayed an immature catching pattern which coincided with the pre-primary teacher's records prior to the commencement of the study. From trapping the ball no score could be recorded for continuous eye contact and elbow flexing. Further analysis on the topography of Nicholas's catching also revealed that he began the catching process with elbows flexed and moved his hands to the level of the ball correctly. As the assessment sessions progressed Nicholas displayed evidence that he was beginning to retain the ball in his hands, from practising his catching and participating in the assessment sessions without any type of instruction. From the data collected on the topography of Nicholas's catching ability, lessons could have been implemented to overcome some of his weaknesses revealed by the topographical checklist. Further intervention was not possible due to the time restraints of this study.

Discussion

Mean topographical responses for Nicholas were stable at three metres and five metres. No improvement in the technique of catching a small ball was evident over the distances of three and five metres.
Nicholas's mean topographical results with a medium sized ball at three and five metres during the study.

**Baseline**

Baseline scores at three and five metres were similar on different assessment days. Scores at three metres were higher than those at five metres except at assessment point three. Nicholas displayed a baseline mean of 2.7 at three metres and 2.1 at five metres.

**Intervention**

Following intervention with one twenty minute instructional session, mean topographical scores increased. At three metres marked improvement in the number of critical elements
during catching occurred and at five metres an improvement was also evident.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
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Table 18

Nicholas's mean topographical scores with a medium sized ball at three and five metres.

Intervention lessons

The topographical checklists of Nicholas's catching ability with a medium sized ball revealed that Nicholas displayed similar characteristics displayed with the smaller ball.

The checklist revealed that as the ball was contacted and drawn to his chest he turned his head away from the ball. Using this strategy was more effective functionally for
catching the medium sized ball. From trapping the ball no score was recorded for continuous eye contact and elbow flexing. As the assessment sessions progressed Nicholas displayed evidence that he was beginning to retain the ball in his hands from practising his catching and participating in the assessment sessions without instruction. From the data collected on the topography of Nicholas’s catching ability, lessons could have been implemented to specifically overcome some of his weaknesses revealed by the topographical checklist.

![Image of Figure 24](image)

**Figure 24.** Nicholas’s mean topographical responses with a medium sized ball at three and five metres.

**Discussion**

The results indicate that catching at three metres displayed a steady improvement from participating in the assessment sessions. At five metres mean topographical scores
remained stable.

Summary of results

Nicholas’s results indicate that although some improvements were noted in functional and topographical terms at three metres, little improvement both functionally and topographically occurred at five metres. No decrease in the level of skill acquisition occurred as a result of participating in the assessment periods.

Subject D: Emma

Emma was a quiet child who listened carefully to all instructions and had a long attention span. Emma’s approach to the assessment sessions was more focussed than the other subjects. Emma appeared more mature than the other subjects and was physically larger. At the beginning of the study, the teacher’s records identified Emma as a high gross motor performer.

Emma remained in baseline throughout the study and was not involved in any of the intervention sessions. Emma’s results were superior to the other subjects and displayed improved catching skills from participating in the assessment sessions.

Emma’s functional scores with a small ball at three and five metres.

Table 19 and Figure 25 display Emma’s functional scores with a small ball over a distance of three and five metres during the study.
Baseline

Baseline behaviour at three metres was unstable with functional scores ranging from one successful catch to five successful catches. Towards the end of the study, functional scores were consistently higher. At five metres scores ranged from one successful catch to five successful catches.

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<th>Five Metres</th>
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Table 19

Emma’s functional scores for catching a small ball at three and five metres.
Discussion

Emma averaged three successful catches at three metres and almost the same for five metres with a small ball throughout the assessment sessions. Emma was the only subject to score five successful catches at five metres with a small ball and score at least one successful catch at each assessment point. These results reflect an accurate assessment of the pre-primary teacher's records when identifying a high gross motor performer prior to the selection of subjects for the study.

![Graph showing Emma's functional responses with a small ball at three and five metres.](image)

**Figure 25.** Emma's functional responses with a small ball at three and five metres.

**Emma's functional scores with a medium sized ball at three and five metres.**

Table 20 and Figure 26 display Emma’s functional score with a medium sized ball over a distance of three and five metres during the assessment period.
Baseline

At both three and five metres baseline behaviour was consistently high. Functional scores at three metres were either four or five successful catches and at five metres scores ranged between two and five successful catches. All assessment points recorded at least one successful catch.

<table>
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<tr>
<td>8</td>
<td>5.0</td>
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<tr>
<td>12</td>
<td>4.0</td>
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<tr>
<td>13</td>
<td>4.0</td>
<td>4.0</td>
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<tr>
<td>14</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>15</td>
<td>5.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Baseline Mean</td>
<td>4.4</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Table 20

Emma’s functional scores for catching a medium sized ball at three and five metres.
Discussion

Again high functional scores were recorded at both three and five metres. Emma's scores between one and three were extremely high at both distances. Between assessment points 12 and 15 a slight decrease in scores was evident. Field notes indicated that Emma became more relaxed and less attentive during the assessment periods which could have contributed to lower scores.

Figure 26. Emma's functional responses with a medium sized ball at three and five metres.

Emma's topographical mean scores with a small ball at three and five metres.

Table 21 and Figure 27 display Emma's mean topographical scores with a small ball over a distance of three and five metres during the assessment periods.
Baseline

At three and five metres, mean topographical scores were relatively high and stable. At three metres scores ranged between 2.6 and 5.2 and at five metres mean topographical scores ranged between 2.4 and 4.2.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.2</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>4.0</td>
<td>2.8</td>
</tr>
<tr>
<td>3</td>
<td>4.0</td>
<td>2.4</td>
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<tr>
<td>4</td>
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<tr>
<td>14</td>
<td>4.4</td>
<td>3.2</td>
</tr>
<tr>
<td>15</td>
<td>5.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Baseline Mean</td>
<td>4.4</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Table 21

Emma’s topographical mean scores with a small ball at three and five metres.


**Discussion**

Emma's results indicate that at three metres most critical elements necessary to catch a small ball were evident. Mature catching is obviously being demonstrated in order to catch the ball successfully. Again at five metres most critical elements that are necessary to catch a ball are present but do not appear as frequently as those elements demonstrated at three metres. A trend between topographical scores on different assessment days is clearly evident when viewing Figure 27. When assessments were made on the same day, similar scores resulted. Improved topographical results at three metres was followed by improved performance at five metres, similarly with decreased performance.

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**Figure 27.** Emma's mean topographical responses with a small sized ball at three and five metres.
Emma's mean topographical scores with a medium sized ball at three and five metres.

Table 22 and Figure 28 display Emma's mean topographical results with a medium sized ball over a distance of three and five metres during the assessment period.

**Baseline**

Baseline scores at three metres and five metres were again very high. Topographical mean scores at three metres ranged between 3.2 and 5.0. Mean scores at five metres ranged between 3.2 and 4.8.

<table>
<thead>
<tr>
<th>Assessment Point</th>
<th>Three Metres</th>
<th>Five Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.4</td>
<td>4.2</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>12</td>
<td>5.0</td>
<td>4.8</td>
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<td>14</td>
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<td>4.4</td>
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<tr>
<td>15</td>
<td>4.4</td>
<td>3.8</td>
</tr>
<tr>
<td>Baseline Mean</td>
<td>4.4</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Table 22

Emma's mean topographical results with a medium sized ball at three and five metres.
Figure 28. Emma's mean topographical responses with a medium sized ball at three and five metres.

Discussion

Topographical scores for both distances were high. A similar trend between topographical scores at three and five metres was apparent. When assessments were made on the same day similar scores resulted. Improved topographical performance at three metres was followed by improved performance at five metres, similarly with decreased performance. Only at assessment points two and eight was there a large difference between mean scores at each distance.
Summary of results

Emma’s results clearly indicate that she was a high gross motor achiever and had a high level of competence when catching a small and medium sized ball at both three and five metres. Prior to the study the pre-primary teacher’s records also identified Emma as a high achiever. Emma’s catching ability improved from participating in the assessment sessions. Although the design of this study attempted to reduce the practice effect, it is clear from Emma’s results, that practice was at least one variable that contributed to improved catching ability.
CONCLUSION and RECOMMENDATIONS

A child's level of motor performance normally improves with age (Wickstrom, 1983), however, there are a number of factors other than aging that contribute to the rate of improvement in performance. The development of fundamental motor skills does not occur automatically, but is under environmental influences (Gallahue, 1989). As a child gets older, the environment begins to play a greater role in skill development. Environmental effects which include opportunities to practice, suitable play equipment, the quality of instruction provided and the interest and encouragement provided by others to a child have been shown to play a significant role in the development and maintenance of fundamental motor skills (Gallahue, 1989).

The pre-school and primary school years have been suggested as being the best time to refine and learn skills (Capon, 1977). Recent research by Walkley et al. (1993) has discovered that many Australian children can not perform fundamental motor skills competently and that the skill level of girls between grades six and eight begins to decline. In later years many more factors such as peer pressure, societal and parental expectations and competition can cause less time to practice and refine skills. Quality instruction and practice opportunities have been identified as critical elements that contribute to fundamental motor skill improvement. Kelly et al. (1989) found that children who received an instructional physical education program performed significantly better than did students who received supervised activity time only.

The purpose of this study was to investigate the effects of a direct instruction motor development program on the catching performance of pre-primary children. Given the
size of the sample, it is not possible to generalise to other populations, however the idiosyncratic nature of the data confirms the importance of individualising intervention programs to promote the development of fundamental motor skills in children.

The multiple probe across subjects design was used to measure the effect of the independent variable on the dependent variable. The multiple probe design was used to reduce the effect of training during the testing periods for those subjects not participating in the intervention. The test itself represented a form of intervention in that skills were practised under teacher guidance. This experimental effect is consistent with a cumulative teaching program.

A total of four subjects were selected from a metropolitan school. A stratified random sample of children was used to select the subjects from the teacher's record file. The strata categories used in this study were: (1) High gross motor performers, (2) Low gross motor performers.

Each subject was evaluated on the functional and topographical components of catching a small and medium sized ball thrown to them by an instructor from distances of three and five metres. The functional measure was referred to as the "Ball Catching Task" or the number of successful catches completed. The qualitative measure consisted of a "Topographical Checklist" of the skill which identified critical elements of each catch. Live coding did not take place, thus allowing the instructor/researcher to focus on reliable test administration. The use of a video camera was used at each assessment session to record the critical elements of the skill accurately. An instructional program involving three twenty minute lessons a week was implemented, designed to improve the catching performance of each selected subject.
The results of the intervention indicated that the catching ability of the selected subjects either improved or remained stable, depending on a number of variables. These variables included the amount of instruction and practice they received, the distance they had to catch the ball and the size of ball they caught. Melanie and Caitlin demonstrated that when they were given instruction and time to practice, an improvement in their catching occurred. Nicholas and Emma who did not receive the instructional program, displayed stable or slight improvements in the skill of catching.

Testing at the shorter distance of three metres appeared to facilitate the greatest improvements both functionally and topographically for Melanie and Caitlin, whilst at five metres inconsistencies were evident. The smaller sized ball appeared to encourage more consistent catching over three metres whilst the medium sized ball displayed a more mature catching pattern. The results do not indicate that one ball proved to be more conducive to catching than the other. The multiple probe design also indicated that those subjects who received little or no instruction displayed improvement from participating in the assessment periods. The results indicate that the children who were exposed to instruction and practice time displayed improvements in their catching ability both functionally and topographically in a relatively short time period. If improvements were recorded in a six week intervention program, one could infer that a similar type of program that encompassed many more skills spanned over the school year or two terms could lead to greater improvements.
Functional responses with a small ball

At a distance of three metres with a small ball the subjects displayed improvements in the number of successful catches they performed. Functional responses over the distance of five metres displayed inconsistent results between subjects. Table 23 displays this data.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Baseline</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanie</td>
<td>3M</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>5M</td>
<td>1.0</td>
</tr>
<tr>
<td>Caitlin</td>
<td>3M</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>5M</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 23
Summary of functional results during baseline and intervention at three and five metres with a small sized ball.

Functional Responses with a Medium Ball

At a distance of three metres with a medium sized ball the subjects' scores were inconsistent. Whilst one subject showed improvements another subject's score remained stable. Functional scores over the distance of five metres tended to remain stable throughout the study. Table 24 displays mean results during baseline and intervention at three and five metres with a medium sized ball for the two subjects who undertook the intervention program.
Table 24

Summary of functional results during baseline and intervention at three and five metres with a medium sized ball.

Topographical responses with a small ball.

At distances of three metres and five metres with a small ball the subjects displayed an improvement in the topography of the skill. Over the intervention period the technique displayed by Melanie and Caitlin to catch a ball had improved. When compared to the medium sized ball the smaller ball demonstrated that it encourages more mature catching patterns.

Table 25

Summary of mean topographical results during baseline and intervention at three and five metres with a small sized ball.
Topographical responses with a medium sized ball

At distances of three and five metres with a medium sized ball the subjects again showed improvements in the topography of the skill, although functional scores revealed little or no improvements.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Baseline</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanie</td>
<td>3M 1.6</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>5M 1.2</td>
<td>2.7</td>
</tr>
<tr>
<td>Caitlin</td>
<td>3M 2.8</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>5M 1.8</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Table 26

Summary of mean topographical results during baseline and intervention at three and five metres with a medium sized ball.

Summary

The data indicates that functional scores either remained stable or displayed improvements. It is important to note that functional scores only tell the researcher, teacher or observer whether a subject was successful in catching the ball or not. Little information is provided in the technique displayed by the subject or the topography of the skill. Functional scores leave little scope for teacher or child to remedy problems by focussing feedback on specific critical elements.

The importance of measuring the topography of a skill is highlighted in these results. Functional responses showed small improvement whilst the topography of the skill
showed greater improvements. The results also demonstrate that the use of a small or large sized ball can contribute to more mature catching patterns being demonstrated.

This study has emphasized that the collection of only functional scores does not give accurate information as to how a child's skill development is progressing. Both functional and topographical data on skill development gives far more insight into skill development. Topographical data identifies critical elements in a particular skill that may need improving. For example, if a child had to catch a ball ten times from a distance of three metres and they scored three successful catches, the researcher/teacher can not make accurate conclusions on the catching ability of that child. However, topographical analysis may reveal that the child is displaying all the critical elements of mature catching but does not have simultaneous hand contact, hence he/she is dropping the ball. Topographical information allows the teacher to intervene at the point of error and allows more accurate conclusions to be made as to the child's level of skill.

**Assessment strengths and weaknesses.**

One aspect noted throughout the study was that following intervention a similar trend developed between topographical mean scores at three and five metres. When assessments were made on the same day similar scores resulted. This outlines the strength of the topographical checklist over repeated assessment points. From such observation we can conclude that similar types of behaviours were exhibited at different distances. On a different day the behaviour altered slightly but scores at three and five metres maintained a similar trend or relationship. This observation was not always the case but was noted on occasions during the data analysis. Figure 29 clearly demonstrates this pattern.
Instruction

Although the instructional program was implemented in the pre-primary setting and designed to be as unobtrusive as possible, it was felt that if the instruction was implemented with more children other than the subject and if it complemented the outdoor "free play" setting where catching could be practiced, then the subjects would have felt less isolated and enjoyed the intervention sessions more. Ideally the intervention program would have been more successful if this program could have been evaluated over a longer time period and incorporated all children in the pre-primary group. Due to the time restraints placed on the research, the amount of instruction implemented for measuring the change in the catching ability was sufficient for only two of the subjects.
The type of activities designed to improve the catching ability of the children were made as simple and adaptable as possible so that they could be used by other practitioners. However, it was clear that during the instructional sessions the subjects enjoyed themselves more when they were surrounded by their peers. Any type of catching activity completed with their peers would have been sufficient providing that the activity did not depend on a throw from their peers. Executing a successful catch can depend on the quality of throw.

**Design of the study**

One of the strengths of this study was in the research design incorporated. The multiple probe design was selected to reduce training effects and to monitor the subjects at various intervals throughout the study. This type of formative assessment was more sensitive and useful in identifying changes in behaviour as opposed to many of the conventional summative type assessments. It also reflects the common assessment practices used in other learning outcomes such as writing and spelling where many work samples are collected.

Although many factors/variables impacted on the data collection, these same factors occur in day to day teaching. Children being absent due to sickness, inclement weather, birthday parties and class excursions were some of the problems experienced in the collection of data. It appeared that activities prior to the intervention sessions had an indirect effect on the concentration spans and attentiveness of the children. For example, if the children had been silently reading before an intervention, the subjects were very attentive and interested in many of the ball catching tasks. If an intervention session followed an art lesson, then
the glue still on the children's fingers appeared to be of more concern than any type of coloured ball being thrown through the air to them.

**Testing procedure**

The strength of the testing procedure was its validity and reliability. Both the ball catching task and the topographical checklist had face validity. Videotaping each assessment session proved to be more reliable than live coding. The testing procedure was deliberately kept simple and easy to follow so it could be easily adapted by any pre-primary teacher and used to assess their children's catching ability. A weakness that arose from the testing procedure was the amount of time taken to complete the testing. A shorter test would have reduced the training effect on the subjects and also allowed the subjects to concentrate more consistently throughout the duration of the test.

**Research Questions**

The following discussion will address the research questions of this study.

1. **What effect will an instructional motor development program have on the catching performance of pre-primary children?**

The results of the study indicated that the direct instruction motor development program improved the catching performance of the two subjects that participated in the intervention lessons. The results of those subjects who did not participate in the intervention lessons but participated in the assessment sessions, indicated that their catching performance remained stable or improved slightly. It is suggested that improvements occurred as a result of the frequent assessments.
a) What topographical changes will occur as a result of the program?

The results indicate that the greatest improvements occurred topographically for both the two intervention subjects at three and five metres. This indicates that for the subjects that participated in the program more critical elements were present at three and five metres at the conclusion of the intervention than before the intervention occurred. Critical elements such as keeping eyes on the ball, giving with the ball, no fear reaction to the oncoming ball displayed increased frequency as the intervention progressed. Hands contacting the ball in unison proved to be the least frequent element throughout the study and the most difficult skill for Melanie and Caitlin to master.

b) What functional changes will occur as a result of the program?

All subject’s functional scores at three metres displayed a notable improvement, in the number of successful catches, whilst at five metres scores were inconsistent.

2. What is the relationship between topographical and functional changes when the results of the program are compared?

On each particular data point collection day functional results tended to coincide with topographical results. For example, if a subject successfully caught a small ball at five metres, then topographical scores would also indicate that many of the critical elements in the skill were present. If a child bobbled a ball and dropped it then it was possible that the number of critical elements present in the catching performance was also high. In this example the only critical element that was not present was “hands contacting the ball in unison”, hence the ball was dropped. Bobbling the ball usually occurred at three metres with a small ball.
3. How much instruction is needed to bring about changes in the catching performance of pre-primary children?

The results in this study indicate that the six week instructional intervention program improved some aspects of the catching performance of two pre-primary children. The design of the study also indicated that the children who did not receive any instruction also improved their catching by participating in the assessment sessions which were in fact practice sessions. During each assessment session a child would perform twenty catches.

   a) How much instruction is needed to bring about changes in the catching performance of high gross motor performers?

When selecting the subjects for the study the stratified random selection method was used. Based on the pre-primary teacher's gross motor development records high and low achievers in the pre-primary group were grouped accordingly then selected. Whilst baseline behaviour was being recorded it was discovered that the pre-primary teacher's records were very accurate. Prior to the intervention, Melanie was identified as a high gross motor performer. The duration of this study indicated that this timeline was sufficient to improve her catching ability. Emma was also identified as a high gross motor performer and as a result of participating in the assessment sessions, displayed improvement in her catching performance.

   b) How much instruction is needed to bring about changes in the catching performance of low gross motor performers?
Prior to the intervention Caitlin was identified as a low gross motor achiever by the pre-primary teacher’s records. Caitlin’s baseline results were low. Following intervention there was an improvement in Caitlin’s catching ability with functional and topographical scores increasing. Nicholas was also identified as a low skilled performer and although he only participated in one intervention lesson his baseline results indicated his catching ability was slowly improving.

Recommendations

More emphasis needs to placed on the development of fundamental motor skills among primary school children (Walkley et al., 1993). Teachers of physical education, be they specialised trained or classroom teachers, need to focus their instruction toward the development of fundamental motor skills from the very early grades of school and this may necessitate drastic curriculum change. Many schools base their physical education programs around the playing of games and sport, and yet, the evidence is clear that the simple provision of unsupervised play, game and sport opportunities is insufficient to allow children to develop motor skills (Walkley et al., 1993). Teachers, coaches, administrators and parents must understand that unless children receive the opportunity to practice and quality instruction needed to develop fundamental motor skills at an early age their future participation in a range of physical activities may be negatively affected.

A recent review of physical education in Western Australian schools (House, 1994) suggests that change within schools need to occur to ensure that children are skilled and physically fit. One of the major recommendations was that the provision of physical education within the junior primary years (K-3) needs to be urgently addressed.
Recommendation #1

In order to ensure that schools are encouraging the development of children’s fundamental motor skills, more effective planning of the type and design of playgrounds and equipment placed in schools needs to occur. By placing developmentally appropriate equipment in playgrounds we create opportunities for children to practice their skills in structured and unstructured environments. The literature suggests that if children are given the opportunity to practice their skills in a safe and non-threatening environment then further skill development will occur. Intervention programs such as the one implemented in this study, should complement less structured play settings where skills such as catching can be practiced in a free play environment. At present many pre-primary playgrounds have too little space to allow for catching, throwing, hitting and kicking activities.

Recommendation #2

Ongoing teacher inservice needs to occur so that classroom teachers have the skills and knowledge to confidently teach and observe/analyse the fundamental motor skills of children. Like any subject area in teaching, knowledge of content area is of primary importance when developing sequentially based lessons. Many teachers do not have the necessary content knowledge to plan sequentially based lessons and intervene where common problems are occurring. It would be extremely rare to find a primary teacher without the necessary skills to intervene at the point of error in mathematics or language. Continual teacher inserviceing and resource support in mathematics and language with the First Steps package has ensured that teachers have the skills to identify problems and
develop appropriate strategies to overcome problems. One recommendation within the House Report (1994) into Physical Education was to ensure that teachers had access to quality programs from specialist teachers within the area. Within a school the Physical Education specialists need to complement the important work completed by classroom teachers. At a district level and school level, professionals with expertise in these areas need to be identified and systems need to be in place so that teachers are able to access these specialists and resources. The networking of resources and information needs to be more prevalent within schools and districts.

In recent years, schools have become more accountable for the types of programs they are offering to students and the outcomes that they are achieving. More decisions are being made at the school level and the need for accurate data in particular subject areas has become more important for school decision making groups. Management information systems are currently being set up by many schools in order to monitor the school's performance indicators. A school's performance indicators should reflect the eight national curriculum areas. One of the national curriculum areas is Health and Physical Education. Presently, schools have very little data or data collection devices to make objective decisions in the performance of students in physical education. With the introduction of monitoring standards in education (MSE) program and the new student outcome statements (SOS) being trialled by the Education Department, schools will soon be able to build up a profile of the standard of physical education within their school. The further development of these initiatives by the Education Department will give teachers more information on the development of skills of children in their class.
Recommendation #3

Further research needs to be completed into the organisation of a developmental continuum or skill development checklist similar to the one used in this study. Information on the progress of fundamental motor skills would be a valuable measuring device for classroom teachers. A developmental continuum would be useful for all teachers in identifying children at risk of not developing skills and high achievers. A profile of the class’s skill development would give teachers more information to plan appropriate activities and be based more at individual children’s needs. The need for more formative evaluation devices is apparent in physical education rather than the more traditional summative type model that has been implemented over the years.

Final summary

This study has attempted to analyse the effect of a direct instruction motor development program on the catching performance of pre-primary children. The results of the study indicate that in the short timeline that this intervention occurred, changes in the catching ability of the selected subjects was evident. It is hoped that this study has highlighted the need and importance of teaching children their fundamental motor skills in the early years. The literature reviewed indicates that the development of fundamental motor skills in all children is part of the total educational process. Unfortunately the standard of motor skill acquisition within Australian schools is below expected standards and many children are being deprived of a quality physical education program (Walkley et al., 1993).
As a result of the applied nature of this study, a motor development program has been developed that may be used in pre-primary settings. The intervention lessons completed in this study are easily adapted to all early childhood settings.
REFERENCES


APPENDICES

1. Data displayed in the multiple probe design.

2. Intervention program.

3. Ball catching task.

4. Observational / Topographical checklist

5. Ball catching task table showing both functional and topographical data.

6. Intervention log

7. Letter of consent
APPENDIX 1: Data displayed in the multiple probe design.
APPENDIX 2: Intervention program.

Outline of prepared lesson plans

The following activities were prepared prior to the intervention program. Individual weaknesses and strengths that were recorded from the topographical instrument determined which activities were suited to an individual’s needs.

Lesson:
1. Familiar with equipment.
   - introduce different types of balls (large to small) and beanbags.
2. Rolling the different sized balls: children try to intercept the ball being rolled to them.
   Use different pathways.
3. Tracking exercises. Children lie on their backs and track a swinging pendulum. eg beanbag tied to skipping rope.
4. Introduce the large ball / close distance (3 metres). Eyes on the ball - watch the ball to your arms
5. Catching a balloon / tapping the balloon in the air for hand eye coordination.
6. Introduce rebound net with large ball.
   Children seated close to net on knees and throw against net attempting to catch.
7. Introduce beanbags / emphasize hand catching.
8. Introduce smaller ball / with appropriate instruction.
9. Practise throwing and catching small ball with feedback.
10. Minor practices with small and large balls.
11. Use rebound net with small ball / increase the distance from where the child is seated.
12. Practise catching where they can not see the projection (ie sheet covers projection).
13. Practise catching swinging beanbags.
Intervention lessons that occurred during the study.

It is important to note that these lessons were designed to improve the catching ability of the subject's involved in the study. The topographical checklist that was used to measure critical elements within each catch revealed individual strengths and weaknesses. Based on checklist, twenty minute lessons were designed to improve weaknesses evident in the process of catching.

Intervention: lesson 1

Suggested activities to introduce different sized balls and the skills necessary for hand catch.

- Sitting opposite child - both with legs apart to stop a rolling ball.
- Roll different sized balls to each other. Progress from medium sized balls to smaller balls.
- Whilst in the sitting position, bounce the balls to each other.
- Stand up opposite each other and bounce different sized balls.
- Instructor bounces the ball to the child whilst the child is standing.
- Demonstrate correct hand position for catching a small ball.
- Stand opposite child and roll a tennis ball along the ground to the child.
- Child must stop the ball with the correct hand position.
- Roll the ball on different pathways to encourage the child to get their body behind the ball.
- Bounce the ball to the child / practise catching the ball in their hands.
- Balloon tapping activity (develop hand-eye coordination)

  1. stand and tap the balloon up and down in the air.

  2. running from designated place to catch the balloon before it lands on the ground.

  3. tapping the balloon in the air around an obstacle course.

Intervention: lesson 2

Balloon tapping (fun activity)

- Sit opposite child - ball rolling seated - different sized balls - large to small.

- Build up from rolling the ball to small bounces of the ball.

  Use a tennis ball.

- Demonstrate hand position for catching tennis balls.

- Standing two metres apart the instructor throws an underarm lob with a tennis ball

- Child attempts to catch the ball using the correct hand position.

- Demonstrate giving/flexing elbows - child attempts correct technique.

- Play a progression game of step back on successful catch / step forward if you drop the ball.

Intervention: lesson 3

- In pairs play a balloon tapping game using both hands.

- Introduce two balloons.
- Sitting on the floor with legs apart facing each other roll different sized balls to each other.

- Move up onto one knee and attempt to catch different sized balls with one bounce.

- On knees catching a tennis ball on the full.

- Progression game- taking a step forward and back depending on outcome of catch.

- Introduce the swinging beanbag from the ceiling.

- Practise keeping eyes on the swinging beanbag and positioning hands in the correct position.

- Play a game of stopping the rolled balls before they hit the wall from different pathways

- stress the use of both hands.

- Attempt to catch a lobbed tennis ball from two metres (similar to the testing procedure).

- Play a game of balloon tapping to end the lesson.

**Intervention: lesson 4**

- Sitting and stopping a rolled ball

- Gradually lead to slightly bounced balls

  - concentrating on hand position

  - flexing elbows on impact

  - keeping the eyes on the ball.

- Progression game with a medium / small ball - step back on successful catch.

- Catching swinging beanbags - Demonstrate the correct hand position / eyes on ball.
**Intervention (short lesson interrupted by other children)**

- Introduce rebound net / launch board to Melanie
- Allow time for practice.
- Play progression catching game
- Balloon tapping around a chair for tracking

**Intervention: lesson 5**

- Demonstrate chest throwing into rebound net and catching correctly.
  - medium ball from one metre
  - stress hand catching
  - children lean on knees
- Introduce the projectile ramp - beanbag
  - tennis ball
- Play progression game. (forward / backward)
- Balloon tapping to conclude activities.

**Intervention: lesson 6**

Intervention with both subjects

- Play balloon tapping game together.
- Tapping to each other (balloon with less air in it so that it floats less)
- Melanie works with a medium sized ball into rebound net (independently)
- Caitlin with instructor catching medium sized ball lobbed from 2m (stress hand catching)
- Play catching progression game together (forward/backward)
- Instructor throws ball to children (similar to testing procedure)
  - children stand opposite the instructor
  - verbal feedback on performance.

**Intervention: lesson 7**

Introduce the swinging beanbags to Melanie and Caitlin together outside.

- demonstrate hand position
- flexing the elbows on impact (Make this as enjoyable as possible).
- add variations to activity

**Intervention: lesson 8**

Introduce the swinging beanbags to Melanie and Caitlin

- demonstrated hand position / giving with the ball.
- children standing next to each other with their own beanbags.
- Instructor throws different sized balls to the children from two metres.
- Lead up to a tennis ball and stress correct hand positioning
  - throw alternatively to each child.
- Demonstrate how to use the projectile board together.
  - one child sets the ball whilst the other hits the board and catches
- Whilst Melanie works on the projectile board, Caitlin works independently on the rebound net with a medium sized ball.
- Melanie then works with teacher catching a small ball

**Intervention: lesson 9**

- With Melanie and Caitlin demonstrate throwing tennis ball up on the spot and catching
  - stress hand position/soft hands/give with the ball
- Demonstrate throwing a tennis ball to each other. Children practise together.
  - stress the correct hand position
- Play the progression game - both at the same time next to each other.
- Melanie practises hand catching with instructor (tennis ball).
- Caitlin works on the projectile ramp by herself (beanbag).
- Move outside and play with the swinging beanbags at the same time outside
  - stress hand position and / elbow flex.
- With both Melanie and Caitlin complete two metre hand catching with a tennis ball.
  - instructor throwing the ball.

**Intervention: lesson 10**

- Intervention with Nicholas, Melanie and Caitlin.
- Sitting three metres apart - sit in a circle / rolling the medium sized ball to each other
  - lead onto tennis ball
- Move to independent working stations.
- Demonstrate how to use the projectile ramp to Nick.
  - allow time for Nick to practice his catching with the projectile ramp
- Melanie and Casey work independently on the rebound net.
  - children sit on knees and use a medium sized ball.

- Change after five minutes and allow time for the children to use another piece of apparatus.

- Play a game of balloon tapping to each other.

- Move outside and play with the swinging beanbags.
  - demonstrate correct technique

- Conclude the lesson with the instructor throwing a tennis ball to each child.

**Intervention: lesson 11**

- Intervention with Melanie, Caitlin and Nick.

- Play progression game with all of the children.
  - stress hand position and elbow flex.

- Reward children for participating in the program.

- Play some games outside.
APPENDIX 3: Ball catching task.

Testing Summary:

* From the three metre mark prepare to give the subject one practice catch.

* On the verbal cue "ready" the instructor will lob the ball directly toward the subject.

* Once the subject has had a practice catch, the test will begin.

* The test will include; five throws directly toward the subject requiring no excessive foot movement.

* One point will be recorded for each time the ball is successfully retained in the hands for three seconds.

* The same procedure will occur for five metres and with the small ball.

If the trajectory of a throw is inconsistent with other throws (bad throw), then this throw will not be included in the data analysis and another throw will be completed.
APPENDIX 4: Observational / Topographical checklist.

The critical elements that will be checked are:

**Readiness phase - head / trunk / arms.**
A. Semi-flexed elbows / elbows pointing downward (e.g. greater than 90 degrees) and at sides.

**Readiness phase - hands.**
B. Hands adjust to the level / fingers point in direction of oncoming ball.

**Action phase.**
C. Hands contact the ball in unison.
D. Ball is retained with the hands only.
E. Eyes follow the flight of the ball until contact is made.
F. Elbows flex to absorb force.
APPENDIX 5: Ball catching task table showing both functional and topographical data.

<table>
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<th>OBSERVATIONAL CHECKLIST</th>
<th>DISTANCE</th>
<th>3M</th>
<th>SIZE</th>
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<th>NAME DATE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<td><strong>SIZE</strong></td>
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<td><strong>NAME DATE</strong></td>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
<td><strong>C</strong></td>
<td><strong>D</strong></td>
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<td><strong>TOTAL</strong></td>
<td><strong>FUNCTIONAL</strong></td>
</tr>
</tbody>
</table>
APPENDIX 6: Intervention log of all subjects

Intervention log


* More children have their eyes on the ball when using the small tennis ball than the larger ball.

* Need to adjust test so that concentration level does not decrease by the time they get to the last distance and ball. e.g. shorten test time.
* Must introduce some type of system so that it is easier to analyse videos. Solution - coloured blocks on the floor.

11/11/91 - Children went on an excursion. The data indicates that Melanie would be the best child to start the intervention.

12/11/91 - Assessed Melanie before intervention. Melanie’s personality / concentration level is more suited than other children.
* Introduced block system for easier analysis.
* Tested children at 3 / 5 metres.
* Intervention 1.
Lesson went approximately 20 minutes. This was far too long for this child. Needs to be 10-15 minutes long.

13/11/91: Assessed Melanie at 3 / 5 metres.
* Intervention 2 with Melanie - rainy day - had to place video camera inside.
18/11/91: Assessed Melanie at 3/5 metres.
* Intervention 3 with Melanie - not interested in test or intervention.

20/11/91: Assessed Emma, Caitlin, Nicholas, Sean, Sarah, Melanie. Melanie's test was extremely rushed. Melanie was outside playing - teacher informed me that I had 30 minutes to complete test and intervention. Time was then shortened by children coming in and interfering with the lesson. Intervention was too short and rushed. Introduced rebound net and launching board.

25/11/91: Children went on an excursion.

Melanie appeared to be very disinterested. This may be due to repeated failure at 5m. Looked very unhappy.
* Intervention with Melanie.
* Instructor was stressed. This was evident in the video.

27/11/91: Assessed Caitlin - lost interest when the small ball was used.
* Did not assess Melanie on this day due to the lack of interest expressed in the last test.
* intervened with both children. This made the intervention far more enjoyable for Melanie.
* Sarah brought in a catching device from home. Half a bottle with string and ball attached.
* During the intervention the teacher cut the session short.
* The situation where the children can still see the other children (eg glass windows), makes the testing conditions very difficult due to distractions, not necessarily from the viewpoint of the children being assessed but from the other children looking to see what the subjects are doing in the other room.
2/12/91: Assessed Caitlin - Caitlin was gluing before the test and kept playing with her fingers throughout the test. This affected her concentration.
* Noticed that when catching with the medium sized ball - Caitlin demonstrated a small ball hand technique which caused low performance with the medium sized ball.
* Assessed Melanie. A lot more interested now that another child was participating in the intervention.
* Intervention 5 - played with beanbags. The children acted silly with each other.

3/12/91: Assessed Caitlin, Melanie.
* Intervention 6 - swinging beanbags / catching practice.

4/12/91: Assessed Sarah, Emma, Nicholas, Caitlin and Melanie.
* The speed/distance factor using the larger ball intimidated the children which decreases performance.
* The velocity of the ball is too great for the children's arms and hands to compensate.
* Could be the equivalent to a mature adult trying to catch a medicine ball.

5/12/91: Assessed Sarah, Sean, Johnathon. This was completed while a class that I was meant to be teaching was on an excursion.

* The trajectory of the ball tended to determine whether the eyes are open or shut and the elbows extended or not.
Teacher was not happy for the children to complete the intervention lesson.

10/12/91: Extremely hot day. 38 degrees in demountable.
Did not complete any assessing or intervention lessons.

* Intervened with Nick, Melanie and Caitlin.
* The problem with the intervention lessons is that there are very few situations of modelling by the instructor from three and five metres.

16/12/91: Did not assess any children. Had to go on school excursion in the morning with another class. Attempted to assess the children in the afternoon but the temperature was 39 degrees. Teacher did not allow me to test. The children played under the sprinklers.

17/12/91: Another very hot day. Afternoon assessment occurred. Assessed Emma, Caitlin, Nick and Melanie. All children were in bathers from being at a morning birthday party.

Whilst assessing Caitlin there were many interruptions which tended to affect her concentration level.

Notes on Melanie
* Stands with other foot forward
* Watch left hand
* Hands in cup shape not coming up (must have developed from home ie hands pointing up)
* Wait for ball
* Swinging beanbags activity is essential for her.
* Must watch the height of the lob when assessing.

Notes on analysis
* One elbow is bent (most probably dominant arm)
* Semi-flexed elbows - differs with each throw because trajectory is not constant.
* Height of the ball makes a difference on eyes being open/closed.
* Adjusted the original test conditions from proposal due to concentration levels.
* Elbow flex in trapping motion is not accepted in analysis.
* Instead of elbows flexing the body tends to flex.
* The further the distance the more extended the elbows (rely on trapping).
* When the ball is thrown, the immediate reaction is to throw the head back.
* Instead of an upward action with the arms (elbow flex), other children have a downward action of the arms. (Nick)
* Success can be determined by the concentration level of the child on the testing day.
* Foot position is a big indicator of success.
* The trajectory of the throw will determine the score in most cases (eg a good throw - lobbed toward the hand position may mean the difference between a 3 or 6 on the topography score).
APPENDIX 7: Letter of consent.

LETTER TO PARTICIPATE:

Dear parent,

My name is Matt Osborne and I am currently teaching in the junior school at West Leeming primary school. As part of my further studies in the area of teacher education I am currently in the process of completing a thesis in the area of motor development in young children.

Next term, with the co-operation of the Principal and pre-primary staff, I would like to randomly choose children to participate in my study in which I will be implementing a program to improve fundamental motor skills. The study will be conducted in the pre-primary setting, for three twenty minute sessions a week throughout fourth term.

If you have any queries as to the nature of this study please do not hesitate to discuss these with me or your child's pre-primary teacher.

Please sign below if you agree to your child being eligible for selection in this study.

Thankyou for your co-operation.

Matt Osborne.

Parent consent: ________________________________