UNIVERSITY OF CAPE TOWN

FACULTY OF EDUCATION

AN INVESTIGATION INTO THE TEACHING AND LEARNING OF SHAPE AND SPACE CONCEPTS IN THE RECEPTION YEAR

A minor dissertation presented in partial fulfillment of the requirements for the Degree of

Master of Philosophy (Teaching)

by

Ana Paula Lombard
DCSANA004

APRIL 2006

DECLARATION

I declare that this dissertation is based on research which is entirely my original work. All information obtained from other sources is noted generally in the text, and specifically in the references.

This work has not been submitted for a degree or examination at another university.

Signed by candidate

Signature Removed

Ana Paula Lombard
University of Cape Town
April 2006

ABSTRACT

AN INVESTIGATION INTO THE TEACHING AND LEARNING OF SHAPE AND SPACE CONCEPTS IN THE RECEPTION YEAR

This study focuses on Reception Year teachers' classrooms. It investigates the state of Numeracy teaching, specifically Shape and Space, teaching at the earliest level of the formal school programme.

The study focuses on six Reception Year teachers from a range of schools in the Cape Peninsula. Through the medium of in-depth interviews, questionnaires and classroom observations these teachers' perceptions of the new curriculum and Outcomes-Based Education was probed. Teachers were observed to ascertain how learning was mediated so that children could make meaning of Shape and Space concepts.

The findings show a reasonable consistency in the teaching approaches of these educators. The majority of teachers admitted insecurity in the field of mathematics teaching, specifically Geometry. In general, they showed little conceptual knowledge, which often resulted in practical, integrated teaching methods which did not extend their learners' conceptual knowledge.

ACKNOWLEDGEMENTS

I would like to thank all those who made this research possible. In particular, I would like to thank the following:

My supervisor, Professor Chris Breen, for his inspiration and support and for believing in me over the years.

The Research Department of the Cape Peninsula University of Technology.

Colleagues and friends who constantly encouraged and supported me over the time of study.

My thanks to the teachers who participated so willingly in this study and who helped me learn so much about teaching.

Finally to my family: Meghan, Claire and my mother, Edith and brothers and sisters who saw me through the triumphs and difficulties of this journey. Thank you for your patience and for believing in me. I could not have done it without you.

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION

Baroody (2000) asks whether "...mathematics instruction for three to five year olds really makes sense?" This study explores this very phenomenon, but narrowing the field down to that of the Shape and Space strand of mathematics and the five to six year old child only. Through the medium of in depth interviews, questionnaires and observations in a small-scale study, an attempt will be made to present a sample scenario of the teaching and learning of Geometry in the Reception Year in the Western Cape

The task of a mathematics educator is complex and demanding.

I taught in Foundation Phase (Grades R – 3) classrooms as a generalist for 15 years. My interest in Mathematics arose, when, in 1991, after six years of teaching, a new approach to mathematics teaching (the problem-centred approach) was introduced by the Education Department. I noticed that by changing my approach with my learners, and take my cue from their understanding, I was able to change one little girl's attitude to mathematics. This was the first inkling I had of the fact that there is not just one way of learning. After three years of working particularly hard at my mathematics teaching, I was invited to lecture at a teacher education institution, initially a teacher's college, and now after many mergers, the Cape Peninsula University of Technology. I have been lecturing Foundation Phase Numeracy Didactics there for eight years. We offer four year Bachelor of Education (B Ed) degrees for the General Education and Training (GET) band (Grades R – 9) and the Further Education and Training (FET) band. I am a didactics lecturer in the Foundation Phase. My role is to prepare first to fourth year pre-service students to teach numeracy in Grades R – 3. In addition to my methodology course, they also attend a three year course in Mathematics content which is not phase specific.

I am passionate about what I do, and I constantly strive to prepare the students to be the best mathematics teachers they can be. There are numerous dimensions in the field of teacher education and especially early childhood development which impact on the rationale of this project. Some of these issues are:

- The field of teacher training;
- The advent of Outcomes Based Education;
- The Numeracy curriculum for the Reception Year; and
- The learner in the Grade R classroom.

1.1 Teacher Education

When Literacy and Numeracy tests were distributed to all Grade 3 learners in the province, the results of tests showed that a large percentage of learners were functioning at inappropriate levels (too low). Some had not even mastered the basic Numeracy and Literacy skills and some had not yet reached Grade 1 level (Du Toit, 2002:13). In the light of the fact that children are faring poorly in the Grade 3 testing of Literacy and Numeracy skills, the focus is falling on the teaching strategies that are being used in schools. This does not exclude pre-service teaching, and has implications for this. Pre-service programmes are being examined to ascertain their effectiveness and to ensure that common didactical principles are adhered to. This is in essence a severe problem. There does not seem to be an accepted set of first principles in place, especially in early childhood development, that shows agreement on how young children learn (Bloch 2005). If this is still undecided, it is difficult to talk about "best practice" as a teacher educator.

I have seen this lack of consensus in practice. The students enrolled for the B Ed degree, spend seven weeks a year in the classroom, teaching. This is in essence the applied competence of the didactics subjects presented at the tertiary institution at which I teach. In the first year of the Foundation Phase course

(preparation to teach Grades R – 3, ages 5 – 8), students spend their seven weeks of practical in Grade R classes. It is important for the students to be adequately prepared for the context which they will face, prior to their teaching practical. They return from their teaching experience with many different stories about the activities they have seen. On reflection, and trying to make sense of this with the students, it occurred to me, especially in the field of numeracy that there was little consistency in their experiences from across the various sites in which they had taught.

I was curious to investigate what really happens in the time spent on numeracy teaching in Grade R classrooms in the Western Cape. What makes teachers teach the way they do? How do they decide what to teach? The only way to do this was to go and research for myself and try to gain some insight into the real 'happenings of the classroom'. Initially, I thought of the old adage: "Those who can, do, those who can't, teach". Perhaps a short period of teaching in a Grade R class would enable me to see for myself what was possible to be achieved with five to six year old learners. In this way, the lectures that I presented would not be in a vacuum, but would be related in some way to what the students might see the teachers doing in the classroom. This proved to be impossible as didactics lecturers are not granted sabbaticals for teaching purposes. A close examination of what was being taught in the classroom, seemed like the next best way of placing learning in a real, rather than an imagined, theoretical context.

An understanding of the context in the teaching and learning of this topic would make the teaching of the didactics of numeracy and specifically that of space and shape, more meaningful to me for my teaching.

1.2 Geometry

Why is the choice of this strand of mathematics so significant? The area of Shape and Space is particularly relevant to me as a novice researcher.

Prior to this study, I found myself trying to explain to my sister the layout of my brother's new home which was totally unfamiliar to her.
"Draw a map for me" she said casually. Suddenly my body froze, and I felt panic. I did not know how to do this! How could I as a mathematics educator admit to being so uncomfortable in this area? Why is it that the thought of a spatial activity could cause such insecurity in me, who claims to be fairly proficient in other strands of mathematics? The reality is that somewhere during the course of my schooling, the topic of Shape and Space was not clearly developed and has led to this lack of confidence. I knew that I was not alone in this.

The teaching of numeracy is compulsory for all Foundation Phase (Grades R – 3) teachers. For this reason, the prior mathematical knowledge of the students arriving in the Faculty of Education directly out of the schooling system is significant. As a starting point to the First Year Didactics course, I explore the students' own mathematical background and experiences. Issues of anxiety surrounding their own learning of mathematics in general and Geometry in particular, are often cited by these students as problematic and a source of negative emotions towards mathematics. Some students go so far as to attribute the difficulties they experienced with the learning of Geometry in high school as the cause of their dislike for mathematics in general. These examples led me to consider whether it was possible that early experiences with Geometry in particular were being taught in such a way that they cause confusions later on.

McAuliffe (1999), states that the Geometry instruction which our primary schools offer is inadequate in providing learners with the necessary thinking skills needed to operate at the level of axiomatic thinking required for most high school

Geometry courses. Agherdien (2004) has established that the Geometry content in the first three years of schooling was limited to the recognizing, naming and describing of the four basic shapes: an equilateral triangle, square, circle and rectangle. She omits however to include the Reception Year in her study. In fact, the Foundation Phase now constitutes four, not only three years of schooling. Therefore I wanted to trace the roots of this teaching back to the children's earliest school experiences with space and shape. De Villiers (1996) claims that the future of secondary school Geometry is dependent on primary school Geometry. After all, it is the reception year teachers who hold the success of primary school Geometry in their hands. It was important to ascertain whether the Geometry taught in these first four years provided a sufficiently adequate foundation on which to base the later more advanced concepts of Euclidian Geometry.

It is with this in mind that Space and Shape at the earliest point in the formal school system (or early concepts of Geometry) has been carefully selected as the topic under scrutiny, as it is a neglected and poorly documented area of mathematics in South Africa, especially at the early childhood phase. As van Niekerk (1997: 5) highlights: "In practice, the number component of mathematical development has been the main focus of the teaching and learning of mathematics in the primary phase". According to Sutherland (1992), in the area of pre-school research, Tizard and Hughes (1984) and Gelman and Gallistel (1978) have focused their research extensively on number work and counting. Reception Year practitioners feel confident in the teaching of these strands. They spend time thinking about and consulting resources so that they can plan number and counting activities as it seems that they have some conceptual understanding of this strand of mathematics. As a result, many more structured number and counting activities, than Shape and Space activities are taught to pre-school children.

A study of initial encounters with the teaching and learning of Geometry has the potential to contribute to the later mathematical development of the learner. As a learner progresses through the school system, it seems that Geometry becomes a problematic subject (TIMSS, 1999). During lecture discussions with my students this phenomenon was found to be evident. When high school learners experience difficulties with Geometry or other mathematical concepts, they are either advised or choose to study mathematics on the Standard Grade, or drop it altogether. Few South African pupils continue to Grade 12 with mathematics on the higher grade. The effects of inadequate Geometry teaching (TIMSS, 1999), can be clearly seen as South African students fared poorly in the TIMSS (1999) mathematics study. High school learners and students struggle to understand concepts, and the possibility exists that a stronger foundation at earlier levels could alleviate this.

1.3 The Curriculum and Outcomes-Based Education

The advent of Outcomes Based Education (OBE) in South Africa has been specifically mandated to address discrepancies in our education system. OBE has signified a shift in thinking from product to process orientated teaching. No longer are educators faced with posing simple questions for the receipt of one-word answers. The policy demands of Curriculum 2005 have added a new dimension to the teaching of mathematics in the Foundation Phase. Skills such as interpretation, reasoning, problem-posing, problem-solving, investigation, and analysing are a few of the requirements included in the Revised National Curriculum Statement for grades R – 9 (Department of Education, 2002:4). The Mathematics learning area promotes amongst other things "an ability (for the learner) to engage in the process of inquiry and investigation" (RNCS, 2002:5). This has profound implications for the implementation of teaching strategies, which encourage the learners to become critical mathematical thinkers. This study intends to gain insight into the extent to which the approaches used by the teacher, encourage an investigative approach by learners in the Reception Year classroom.

A change in approach by teachers to the teaching of numeracy in the reception year is now mandatory. The Western Cape Education Department (WCED) has presented workshops for teachers in the Outcomes Based approach to teaching. It seems that thus far, these interventions have not achieved the desired shift in practice. Breen (1999) in Graven (2002 :8), alludes to the need for attention to be given to "what mathematics teachers are doing in the classroom" instead of looking to external factors for inspiration to change

In addition to the enquiry-based techniques which are now required by teachers, the Foundation Phase focus for the study of Shape and Space states the following: "Learners should handle objects and shapes, cut out and draw sketches, and describe them with appropriate and expanding vocabulary" (RNCS, 2002:10). This study, through careful observation, sets out to scrutinize the methods that educators use to ensure that these processes and curriculum demands are taking place.

1.4 Needs of the learners

The fourth dimension impacting on this project is the class of 5 – 6 year old learners known as the Reception Year. The Reception Year has recently been formally included in the Foundation Phase of the GET band of schooling. Formerly, all pre-school education was seen as separate from that of the Primary School. This incorporation has brought with it the expectation that a prescribed numeracy curriculum be taught to Grade R learners. The Foundation Phase learning programme is developmental and now begins in the Reception Year instead of in Grade One, as was the case previously. It was therefore important to ascertain whether teachers had made this shift towards a more structured learning approach, still maintaining the needs of the learners in terms of informal learning approaches.

In addition, the school-going age has been changed from six years to seven years of age. This means that a child in the Reception year is now a year older

than previously and is now at a more advanced stage of development. As these new dimensions occur, an investigation into how the learning of the prescribed mathematical concepts of Shape and Space are being taught in the Reception Year classroom is warranted.

In an earlier investigation conducted by the researcher (Lombard, 2002) it is apparent that the perceptions of Reception Year teachers regard the presentation of Shape and Space activities as follows:

- "I teach them to recognise shapes and say the names"
- "We use workbooks and worksheets, especially towards the end of the year"
- "We set out obstacle courses during outdoor play time"
- "The children play in the block corner and understand the use of space with different shapes"

This raises the question: Are methodologies and practices, which are developmentally appropriate for 5 –6 year olds, being exercised in the Reception Year classroom?

1.5 This research project

Given the above, I decided to focus my research on the task of getting a snapshot view of the backgrounds, beliefs and practices of six Reception Year teachers who taught at six different schools located in the Cape Town metropolitan area. I chose to restrict the study to the topic of Shape and Space and the class to the five to six year olds in the Reception Year class.

1.6 Significance of this research

It is hoped that this study will contribute to much needed research in the field of Early Childhood Development (ECD). Currently, there is very little formal documented South African research in this field, and especially at the Reception

Year stage. This lack is clearly evident in the fact that there is no South African peer-reviewed journal directed specifically at ECD.

Finally, it is well documented in journals such as *Arithmetic Teacher* (see for example the special edition 37(6) of1990) that the development of spatial sense and spatial abilities is as essential as number work in mathematics education so that learners can experience the full range of the mathematical sciences. Shape and Space concepts "relate to the real world and people's orientation to the real world." (Shaw, 1990:4). Del Grande (1990: 19) argues that including informal Geometry activities in the primary school can improve the spatial perception of learners. He continues that the learning of Geometry and an improvement in spatial abilities are 'interdependent', thus further strengthening the need for an in-depth study into the teaching and learning of Shape and Space concepts. Early development in this field could contribute to "...future success in mathematics and other fields as well" (Del Grande 1990:20).

Breen (2003) referring to the Teacher Research Movement outlines the change in educational research towards more conversation with other educators that would ground theory in practice. Traditionally, university research has been out of the reach of teachers, and has not been incorporated in the teaching and learning practices in schools (Breen, 2003). It was apparent to me as a teacher educator, that this was indeed the case.

By closely observing teachers as they approach the teaching of Shape and Space and listening to them as they reflect on their practice, I hope to come to a clearer understanding of both this subject and how it is being taught in the classroom.

This dissertation will assume an investigative approach, and will be multi-faceted. Firstly, in Chapter One, I have outlined the background for and need to conduct this study.

In Chapter Two, I will examine some of the literature related to the topics of the subject matter of Geometry, and the current thinking on appropriate selection of materials for early Shape and Space activities. In addition, I will examine theories of teaching and learning mathematics in the early years, and lastly, I will examine the demands of the new Outcomes Based Curriculum as outlined in the RNCS. This will be used to inform my analysis of the data.

Chapter Three describes the methodology used to collect the data used in this research. This chapter addresses some of the questions raised in the introduction.

Chapter Four tells the stories of the six teachers, their theories and practices with regards to the teaching and learning of Shape and Space concepts. It gives an overview of some of the ways in which teachers are addressing Learning Outcome Three of the RNCS.

In Chapter Five, this data is scrutinised and analysed in terms of the literature which has been examined and questions posed.

Chapter Six concludes this study by addressing some of the implications of the findings.

CHAPTER 2: LITERATURE REVIEW

In this chapter, I examine literature which pertains to the teaching and learning of Shape and Space concepts (Geometry). When reviewing the current thinking on this topic, I particularly focused on the following:

- A scrutiny of the concept of Geometry, specifically looking at what the recommendations are for the laying down of early concepts,
- Theories on the teaching and learning of mathematics, particularly Geometry, and
- The demands of the new curriculum and Outcomes Based Education (OBE).

2.1 Why Geometry?

Egsgard (1970) says that Geometry is the study of spatial relationships of all kinds. These relationships are found both in the three-dimensional Space around us, and on any two-dimensional surface in this three-dimensional Space.

This study deals specifically with the mathematical strand of Shape and Space. Traditionally, this domain is not given focused attention in the early grades, and yet the literature states categorically that Geometry is a vital area which must be developed, not only for success in mathematics later on, but for a variety of reasons.

Teachers' lab (1997 – 2005), gives several reasons why Geometry is an important strand of mathematics. We live in a three-dimensional world, built of Shape and Space. Children are aware of spatial relationships from their earliest days (Egsgard, 1970). It follows then that by the early introduction of Shape and Space concepts, children will be made aware that mathematics is a vital part of their world. Early informal Geometry is also an excellent preparation for later,

more abstract concepts. Children will have difficulty understanding abstract ideas if they have not had adequate experience with concrete tasks. Geometry can also be beneficial to children solving problems. Sometimes, it can help children to solve problems from other fields, if they represent the problems geometrically. Because Geometry helps children to visualize, and to think visually, this can "be a doorway to success in mathematics" (Teachers' lab, 1997:1). They continue by outlining some very powerful visualization activities which could be useful to teachers for developing this skill in young children.

Bennie (1998:5) extrapolates that It is impossible to exist in a world without spatial skills .The ability to "perceive spatial relationships is important for everyday activities such as reading maps, playing sport, technical and scientific occupations and the study of mathematics itself."

"Geometry derives from the sense of spatial relationship which develops from co-ordination of muscles, eyes and mental imagery, enabling us to imagine and reason about both the physically possible and the physically impossible. " In addition, "algebra and arithmetic are essentially analytic: they arise from actions which dissect experience into fragments. Geometry is essentially intuitive and holistic" (Mason, 1990:1)

It therefore clear that the teaching of Shape and Space concepts is essential for many aspects of real-world living. An early start in concrete experiences with these concepts is therefore essential to the development of Geometry later on in children's' schooling. According to Clements (2000:6), "children are better prepared for all school tasks when they gain the thinking tools and representational competence of geometric and spatial sense".

2.2 Teaching and Learning Geometry.

2.2.1 Some thoughts on learning and understanding Geometry.

Many early theories of teaching and learning lay the groundwork for our perception of how young children develop mathematical understanding. Behaviourism, an early model of learning as advocated by Skinner (See for example Sutherland, 1992 and Gagne, 1985) proposed that results could be achieved by the drilling of mathematical facts in isolation, using a linear, step by step approach from the simple to the more complex. This teacher-directed transfer approach, with the adult as the 'sage on the stage', predominated, and little examination of individual backgrounds and responses of children or their ability to exercise inductive reasoning, was apparent. Many teachers practising today were taught using this method, and this study will consider whether this approach is being used in the teaching of Shape and Space concepts to Reception Year learners.

Since the early behaviouristic teaching approaches, there has been a movement towards ways of teaching which are more age appropriate. The work of Anghileri (1995) comments that the work of Piaget (1964) has had a profound impact on the didactical approaches used in pre-school numeracy. His suggestion of the developmental nature of learning and cognition of the individual has for many years been the predominant school of thought of early childhood educators, and was a shift from Skinner's philosophy of an extrinsic reward being the motivation for learning to take place. Piaget sees the child moving through various stages of development at different ages. The principles of 'assimilation' (leaning new knowledge by relating it to existing knowledge) and 'accommodation' (changing the existing knowledge framework to accommodate the new knowledge learned) are fundamental principles which form the basis of the constructivist approach. As children interact with their environments, seeing, listening and touching things, they make sense of their experiences by relating new phenomena to

those they already know. In this way they develop understanding and acquire knowledge as an internalised structure of their thinking. The major limitation of this theory for the purposes of this study is the absence of discussion of the teacher's role.

Teaching Geometry in the early years (Grades R – 6) of schooling is very different from the Intermediate and Senior Phases. It has been described as the most challenging of all teaching (Egsgard, 1970). Piaget has categorized the cognitive development of children into 3 stages in Primary school:

i) The pre-operational stage, in which the child learns through seeing and touching, (Grades R – 2)
ii) The stage of concrete operations, during which children make comparisons and are able to make simple analyses. (Grades 2 or 3 to 6)
iii) The formal operational stage, where children make constructions, generalize, and highlight specific properties. (Grades 7 and above).

If Grade R learners are mostly at the pre-operational stage of development, then appropriate activities would be playing with, sorting and ordering solid Shapes such as spheres, cubes, prisms and pyramids, using the visual and haptic senses. Egsgard (1970) says that it is more important to sort and recognize similarities of solids in kindergarten, than to learn the names of the Shapes. Once children have examined the faces of the solids, they will progress to working with two-dimensional Shapes. Finally, the concepts of "line segment and point, will eventually grow from the experience the children have with the edges and vertices of solids" (Egsard, 1970:481). He continues with some practical suggestions. The building of walls, he says, will help children to discover the properties of Shapes, by working out which ones fit together best, and why.

Vygotsky, (in Lee and Das Gupta, 1995), opposes Piaget's view that the child's cognitive development is a spontaneous, *internal* process. He argues for the cultural significance of concepts, language, and world view. Vygotsky's theory declares that learning is social in origin. He believes that dialogue with adults is an important aspect of learning. He proposes that the role of the facilitator is to challenge the learner by working in the zone of proximal development. The task of the adult or peer when children are solving problems is to extend the learner beyond their comfort zone and in this way achieve a higher level of cognition.

Bruner's (1966) discovery learning principle has as its basis, the premise that a discovery approach will encourage the development of thinking. As early as 1962, the Committee on learning and the Educational Process of the Social Science Research Council, considered this approach to have such value, yet was so confusing to educators, that a conference was devoted to this subject (Shulman and Keislar,1966). The emphasis of the approach is on the importance of understanding and reasoning in the subject or concept being taught and learned (Anghileri, 1995 and Tomei, 1998). The role of the educator was strongly promoted as a means of encouraging learners to 'discover' relationships and connections between ideas and concepts. Bruner (1966: 103) argued that discovery learning ensures a high level of transfer. In Geometry in particular, it is essential that learners are able to use their knowledge of Space and Shape concepts in Geography (map reading and making), Art (perspective and Space dynamics), Music (pattern and sequences in Space and time), Engineering and of course, the study of Mathematics and Science. The reverse can be argued too. It is through the learning of the discrete subjects Geography, Art, Music that the concepts of Geometry are taught in context and therefore developed with understanding.

Biggs in Egsgard (1970) advocates a discovery approach, in groups, for the teaching of Geometry in the early years, comprising:

- children discovering for themselves,

- followed by discussion to find out about the children's' thinking,
- and the solving of problems (she calls this practical work) which occur in the children's physical environment.

Learning in this way will allow children to practice 'thinking mathematically'.

The principles of Bruner have been used and extended by Human, Murray and Olivier (1992). Since the early nineties, educators in South Africa have been implementing a problem-centred approach to the teaching and learning of mathematics as advocated by Human et al (1992). Meaning and context, absent in the work of earlier theorists, are considered to be essential components in the teaching of mathematics. This socio-constructivist based problem-centred approach has attempted to take the teacher off the centre stage and put the child at the core of the learning process. According to Davis, (1996:183): "Constructivists consider knowledge to be a human construction that is to be evaluated according to its fit with the world of human experience."

The doctoral work of Dina van-Hiele Geldof and Pierre van Hiele led to a description of five discrete levels of understanding for the development of geometric concepts. These are: Visualization, (seeing objects as a whole), Analysis (describing figures by their properties), Informal deduction (the evolution of relationships), Deduction (the stage in which theories and proofs are constructed), and Rigor (where different geometries are explored) (Pegg and Davey, 1991). It is clear that learners must proceed systematically through these levels without omitting any. It is also important that teaching be aimed at the level of the learner. It is clear that most Grade R learners will fall in the category of Level 1: Visualisation. Pegg and Davey (1991:10) state categorically that: "Learning by rote is at no level".

Further exploring early Geometry, Troutman and Lichtenberg (1995:420) state that before the age of 4, children begin to acquire topological concepts such as

"open/closed, inside/outside/boundary, separation /connectedness order and proximity". At this age, ideas about Shape, size direction and angle do not develop. The reason for this is that young children see objects as a different Shape, each time that they see a different view of it. From ages 4 – 7, children begin to develop some Euclidean Geometry concepts (i.e. size, Shape, direction and angle). In addition, spatial relationships develop, first randomly, and later objects are perceived in relation to each other. This leads to ideas about left, right and symmetry. Therefore, children in the preschool and first grade should be assisted by carefully selected activities, to:

- "refine the topological ideas they have begun to develop,
- be assisted to make the transition from topological ideas to simple Euclidian ideas, and
- be exposed to activities which help them discover properties of Space, and relationships in Space." (Troutman and Lichtenberg, 1995:422)

They particularly encourage the use of free drawing (which should follow careful observation), rather than photocopied worksheets which will "interfere with learning to make discriminating observations." (Troutman and Lichtenberg, 1995:423)

According to Teachers' lab (1997 – 2005:1), the earliest shape activities in school should deal with identifying different figures. They continue, by adding that later, using concrete apparatus, the relationships between shapes should be explored: "Can you make a square out of triangles?" They further extrapolate that "Geometry suffers because we have the mistaken impression that is doesn't become real, serious mathematics until it gets abstract and we deal with proof." It is clear from the literature that well-formulated concrete activities early on in the child's schooling, will lead to an ability to understand abstraction in Geometry later on.

In the learning trajectory developed by the Freudenthal Institute (van den Heuvel-Panhuizen and Buys, 2005) clear guidelines have been developed for the teaching of Geometry, starting in the earliest years of kindergarten 1 and 2 (ages 4 – 5). Three key aspects of Geometry are described, namely:

- Orienting
- Constructing and
- Operating with Shapes and figures.

These are clearly described in terms of content, purpose, and practical activities, some of which are elaborated on in accompanying video clips on a CD. Higher-order problem-solving skills are promoted, such as visualizing the design for a 'little man' who no longer wishes to live in a shoe-box. The overwhelming thread through all of the activities presented is that the teacher drives the thinking process through carefully formulated questions. This implies however, that the teacher has sufficient conceptual understanding herself, to be able to conduct this procedure. This dilemma will be explored further later in this chapter.

In line with current thinking, emphasis is placed on experiential activities, supported with mathematical language, through teacher interactions. "Searching for answers to why-questions is very important for the further development of geometric insight". Furthermore, van den Heuvel-Panhuizen and Buys (2005:146) state that "getting acquainted with this language definitely comprises more than knowing geometric terms for Shapes and figures". An integrated approach is advocated, through the medium of stories and puppets. They also highlight the fact that, in the early years, many concepts are taught incidentally throughout the school day. They warn however, that this is not sufficient. In addition to the opportunistic inclusions of Shape and Space concepts, structured geometric activities must still be designed and presented by the teacher.

Hiebert et al (1997) have probed the meaning of the word 'understanding' extensively as there are many assumptions around this expression. A useful definition by Hiebert et al (1997:3) is:

> "...the students are always challenged to think and to try and make sense of what they are doing..."

This classroom-based research will investigate the teaching and learning of Shape and Space to ascertain whether conceptual understanding is taking place.

2.2.2 Teaching Geometry

Little has been written which specifically relates to the teaching of mathematics in the very early years. It is evident, however, that there is a general debate around what teachers need to know in order to be successful teachers of mathematics. According to Ball (2000:246), "what teachers need to know, how they need to know it and helping them to use it", is a pre-service teacher education dilemma that needs further examination.

There is agreement that the teaching of mathematics is hampered by several factors. One of these is the school system itself. Ball, Hill and Bass (2005:14) say that "most teachers are graduates of the very system that we seek to improve." Many Grade R teachers in this study did not even complete mathematics up to Grade 12, and most received no mathematics training in their pre-service education.

In the ongoing discussion as to what teachers need to know in order to teach mathematics successfully, Ball et al (2005:17) pose the question as to whether this should be subject knowledge or method knowledge. She further extrapolates that teaching successfully requires "reasoning, insight, understanding and skill in the subject." In addition, teachers should be able to use mathematical language fluently to be able to help the learners to grasp concepts. In this article, she

referred specifically to teaching third-graders, but the same could be said to be true for learners in Grade R.

Aside from a good content knowledge of mathematics, a pedagogical content knowledge which links to developmentally appropriate practice, and the ability to create a positive working environment, a good mathematics teacher also has to have a set of well thought out theories about mathematics, according to Philippou and Christou (1997), Mason (1990) and Hobden and Matthee (2004). It is important for teachers to have a sincere belief in the importance of mathematics for daily living, thus giving a high regard to planning and teaching sound mathematics lessons for their learners. If teachers are to value the learners' cognitive powers, then they will encourage children to talk about and make sense of concepts for themselves, rather than rely on chorus responses and rote learning of facts during mathematics lessons.

A pre-school principal (Rorvik, 2005) asked me the following question; "I have taught my children cuboid, prism, and ovoid, and I really don't think it is very useful. What should I be doing?" She proved what the above authors have found with respect to valuing mathematics, and she knew she was able to 'do more', but could not see a reason or a broader perspective on the teaching of names of three-dimensional figures. In her mind, she had a feeling that the children's' knowledge had to be extended, but the purpose to her was unclear.

It is apparent from literature, that teachers see the teaching of Geometry concepts in a negative light. Bennie (1998:1) found that "some primary teachers even ignore the presence of Geometry in the curriculum." In my experience, in an investigative questionnaire conducted prior to this research, (Lombard, 2002), few Reception Year teachers saw the importance of Geometry in the early years, and many had not even thought to structure Shape and Space activities as part of their daily programme. Comments were made such as:

"This is rather a new concept for me..."
"... (teaching) Space is more elusive – more ideas needed on this aspect"
"... (the new curriculum) hasn't impacted on my teaching of Shape and Space concepts"
"We don't teach Geometry – we teach early numeracy skills"
"I'm not sure what you mean by Geometry, as children of this age can't measure and don't have any concept of angles yet"
These comments show the teacher insecurities and misconceptions.

Shulman (1986) categorizes teacher knowledge into three kinds: subject-matter knowledge, i.e. the mathematical knowledge of the teacher; pedagogical content knowledge, described as the ideas for presenting the subject matter and the best way to interpret concepts for the learners; and curricular knowledge, which are the resources available to teach the mathematical concepts. These three types of knowledge acquired from both time spent in school as a learner, and in pre-service teacher education, work together in providing the model which the teacher uses to inform the day-to day activities and interactions which are present in the classroom.

Furthermore, Fennema and Loef Franke (1992:161) provide an in-depth review of literature that deals with the question of teacher knowledge and its impact on the quality of classroom instruction and the level of pupil learning that takes place. They conclude that content knowledge "does influence the decisions teachers make about classroom instruction." In particular, a first grade teacher with an expert knowledge of addition and subtraction was found to have evidence of rich responses from the children, which the teacher followed up with further discussion and the children made significant progress in this area. When teaching fractions on the other hand, of which the teacher had limited content knowledge, there was less discussion and the children's' progress was less dramatic. Philippou and Christou (1997) agree with the premise that teacher conceptions about mathematics will affect the lessons they teach.

Fennema and Loef Franke also highlight the significance of knowledge of learners, and of how children learn mathematics (pedagogical content knowledge). This is crucial when teaching learners who are already competent in the basic content which appears in the curriculum. They further deduce that "teachers can attend to individual students when they have appropriate and well organized knowledge" (1992:150), implying that recognizing children's thinking process will help to develop their self-concept, thus improving the level of teaching and learning in the classroom.

2.2.3 Tasks and Tools

It is important, says Lawler (1990:188) to take into consideration that "some cognitive structures are descended from ancestors in the locomotive subsystem and others from ancestors in the visual subsystem". He continues to say that physical activity by the learner plays a large part in the creation of knowledge. The concrete 'playing out' of a concept will later link to more abstract conceptual development. This is in line with the early childhood philosophy of learning through the body or learning through play.

The selection of tasks, says Ball (2000:242) is crucial. Teachers must think about the tasks they use with learners: "Would this be a good task for my students... Is it worthwhile in terms of what my students might learn?" She claims that a capable mathematics teacher should be able to conduct a process of "appraising, selecting and modifying" resource materials for use in her classroom (Ball, 2000:244).

The introduction of a new curriculum further complicates this situation, as teachers may not always understand the concept that they are required to teach. As a result, tasks presented may not only be poorly chosen, but also incorrectly matched to the concept that must be taught.

Activities which are age-appropriate will guide the learners' conceptual development of Geometry. Hiebert et al (1997) maintain that the nature of tasks presented influences the learner's perception of what mathematics is. For example, in the case of Shape and Space it is questionable whether mere recognition of geometric Shapes and colouring-in activities be considered mathematical.

The use of mathematical tools as learning supports implies that age-appropriate mathematical apparatus should be used during the presentation of Geometry tasks. Bruner in Tomei (1998) believes that children progress through three stages of cognitive growth. The *enactive*, or manipulative phase, using real objects to make sense of their world, the *iconic* or pictorial stage, where the image is used to represent thought, and finally the *symbolic* stage, where the child is able to use abstract symbols to understand and represent the world. It is therefore essential that in the Early Childhood Development (ECD) phase, the teacher selects meaningful, geometrical apparatus such as simple to complex two and three dimensional Shapes and forms, in order to make the understanding of concepts possible.

While conducting an internet search on Geometry teaching, one is faced with a plethora of ideas and approaches. Geometry can be taught through art, architecture, origami, quilts, technology, computers and calculators, geography, even through the medium of mini golf and poetry. Thousands of sample activities are presented, all tried and tested by teachers, many with downloadable lesson plans and reproducible worksheets. Why then is it so difficult for teachers to present these activities to children in a comprehensible and age-appropriate way? What should teachers teach?

2.2.4 Language in teaching

In the ECD field, the informal style of presenting activities means that language is at the forefront of every task that happens during the school day. By virtue of the fact that children are unable to read and write in the pre-school years, most of the numeracy activities are verbally presented, or else they are supported strongly by language while interaction with games or apparatus takes place. The teacher is therefore the mediator of language and exposes the children to the correct mathematical terminology. The second dimension, the *role of the teacher* in presenting these tasks is one which Hiebert et al (1997) consider to be vital. The teacher's role is one of listener in which the educator must maintain a balance between respecting the inherent mathematical knowledge of their learners, and guiding and scaffolding discovery through the use of appropriate terminology and questioning. The art of language development and meaning making on the part of the teacher, demands careful consideration as to when to speak and when to be quiet.

Donaldson (1978:60) also states that the reason why young children do not make sense of tasks presented to them, therefore leading to a lack of understanding, is because they cannot comprehend the language being used by the adult facilitator. Irwin and Ginsburg (2001) conducted their research with young children undertaking mathematical activities in group situations. They discovered that in addition to the lack of insight on the part of the learner, the teacher has difficulty understanding what the child already knows. The reason for this was that language terms differ, and children may be unwilling to talk about what they know.

Kontos and Wilcox-Herzog (1997) point us to the importance of valuable teacher interactions with children as being those which involve the use of stimulating questions rather than simply giving instructions or making statements. Positive teacher-child interactions can lead to accelerated cognitive development. Steele

(1999/2000) encourages a way of interacting with children that encourages both the learners and teachers to 'become aware' of thinking. She advocates the use of reasoning in a "safe' learning environment. This would suppose that teachers would pose probing questions that require processing, rather than firing short closed question where quick one-word responses are required. Teachers would ask learners to give reasons for their answers, rather than rewarding responses as being correct. Good teaching is about creating the situations in which intelligent questions can be asked, rather than children simply answering intelligent questions intelligently, say the Panel of Educational Research and Development in Wallach and Nathan (1965).

In addition, Irwin and Ginsburg (2001) say that teachers need to pay attention to the language that children use during free-play activities, to gain awareness of their mathematical understanding. By observing and listening to, young learners at play, some understanding could be gained of their level of understanding of Shape and Space concepts. As a result, activities could be pitched at their level, and children's knowledge could be extended further, rather than remain static.

Ball (2000:243) states that during class discussions, "teachers must make decisions about which (and whose) ideas to pick up and pursue, and which (and whose) to let drop." A teacher requires a sophisticated level of mathematical understanding and insight in order to be able to do this.

2.2.5 Other factors

It is the right of each reception year learner to have equal access to mathematics, whether they show a propensity for the subject or not. In higher grades, mathematics classes are streamed according to the ability of the pupil. Possibly, this scenario begins in the early years, when the child who shows an interest in mathematical concepts, or uses Shape vocabulary during block play, is encouraged to develop these concepts further, and the young learner who

shows little curiosity in the field of mathematics, remains unsupported in their mathematical development. An American study by Viadero (1998) of gender bias in the teaching of mathematics to preschoolers and kindergarteners found that mathematically gifted students stayed ahead of their classmates in math ability, despite extra-mural support being given to the less skilled pupils. It is therefore possible that learners who do not naturally select mathematical activities when given a free choice, are not being given the opportunities to develop mathematical concepts in the same way as the learners who are more likely to select a task of a mathematical nature. It is enticing and 'easy' for an educator to extend the knowledge and understanding of the child who easily grasps and is interested in mathematical tasks, but it is precisely the child who shies away from such tasks, who finds it difficult, who needs one-on-one teacher intervention and encouragement.

> "Most likely, children with mathematical talent are receiving more individualized attention in the classroom than anyone previously thought, and these children are given opportunities to move ahead at their own pace". (Viadero, 1998: 33)

Whitebread (1995:11,12) acknowledges the need for children to understand mathematical processes and develop clear mathematical thinking. He sees the similarity between emergent mathematics and emergent literacy. He identifies four chief characteristics which are essential in introducing young children into the world of formal mathematics:

- the context which is used for the task;
- the role of the teacher;
- the use of language; and
- the child being allowed to use his/her own strategy.

The selection of meaningful mathematical tasks and the role of the teacher are of primary importance to both researchers.

Finally, when discussing the phenomenon of understanding mathematical concepts, it becomes vital to pose the question: How do we know that the learner has acquired the deep structures of learning referred to earlier? De Corte (2000:35) refers to the ultimate goal of mathematics teaching as being one of "acquiring a mathematics disposition". There is a requisite mastery of five categories of aptitude, namely a sound content knowledge base, systematic problem-solving methods, metacognitive knowledge, self-reflection and awareness of a social context for mathematics." This research will investigate whether teachers are able to promote meaningful understanding in their Grade R learners.

2.3 The Impact of Outcomes Based Education

In 1993, apartheid was beginning its dismantling, and the South African Constitution was being worked on. The education system needed much attention from an articulated principle of different and unequal education which emanated from the time of H.F. Verwoerd. Outcomes-based Education was proposed as a way in which equal education for all could be provided, and this was embodied in Curriculum 2005. Outcomes-Based Education "rephrased the question of educational quality in terms of the *significance of learning experiences* rather than the *content of the inputs*. It proffered the moving of *all* schools from the strait-jacketing, rigid and authoritarian experiences of the past, and enabled schools to *design context-based, innovative* and *individualised teaching* and *learning* experiences suited to learners in their particular settings, while being consistent with *national goals*." (Mahomed, 1999:162)

While Curriculum 2005 was seen to be progressive in some circles, and while many considered the philosophy underpinning C2005 to be sound (Mahomed, 1999), the then-Minister of Education, Kader Asmal, set up a committee of review. Overall, the committee found that the language in the policy documents was complex and difficult to understand, new concepts and new terminology,

often couched in vague jargon, left teachers high and dry—they did not know *how*, when or *what* to teach. In addition, training was too often sporadic and uneven. Jansen, (1999b:208) reports on a study of grade 1 classrooms in 1998, that "teachers uniformly felt that their preparation for OBE implementation was inadequate and incomplete".

The original proposal (Curriculum 2005, prepared in 1997) was re-worked, simplified and streamlined, leading to the Revised National Curriculum Statement (RNCS). This was done in 2002. Some principles were tightened, some changed, and some stayed constant. The main features of the RNCS are:

- There are eight learning areas common to the General Education and Training band, with each learning area comprising, on average, four to five learning outcomes. Each outcome has a number of assessment standards, akin to guiding the formation of a syllabus (In Curriculum 2005, much detail regarding content was lacking.) These Assessment Standards thus show both the level and range required for each grade.
- Learners (rather than pupils) are [still] actively involved as participants in their education. In addition, formulated critical outcomes guide the educator into ensuring that educational principles are compatible with OBE guidelines.
- According to Heinemann (2005:2), "Outcomes do not depend on the content. Outcomes are the results of learning, and can be measured and assessed." This has many implications for the teaching and learning of Shape and Space in earlier years. It could be argued that the production of a suitable *context* can create an atmosphere more suited to discovery and learning in the Foundation Phase child.
- Critical and Developmental Outcomes still underpin the whole curriculum. Educators, in all grades, must be aware of these – HIV/AIDS education, human rights, social justice, the democratic process, a healthy environment, inclusive education, the use of IT, and equitable distribution

of resources, are among issues articulated – which must be integrated within the curriculum. (This is done through the umbrella of "Life Skills" in the Foundation Phase.)

- Among other issues central to the RNCS are:

    - A high level of knowledge, skills and values for all
    - Continuous and ongoing assessment
    - Clarity and accessibility
    - Progression and integration can be seen by a random sampling of publishers, OBE should Shape the learning process itself – "the process of learning is considered to be as important as what is learnt." (Heinemann, 2005:5)

Thus, there is a great deal of emphasis on assessing how learning takes place as well as what type of learning, a blend, almost, of qualitative and quantitative "methodologies" at work. The RNCS attempts to enable educators to produce well-rounded, critical and aware learners. It has certainly streamlined C2005, although administrative demands are still made on teachers. The sophisticated and big demand on assessment can lose value and power if classes continue to be too large.

On the whole, though, RNCS is certainly a more streamlined approach than C2005, although it is still bulky and difficult for all educators to administer fairly, consistently and constantly. Perhaps it needs even more shortening.

The story of OBE is controversial indeed. The lofty ideals of a competency-based education and training system have been vociferously attacked by Jonathan Jansen (1999a) in a paper entitled "Why Outcomes-based Education will fail: an elaboration". He outlines ten major reasons why OBE will "impact negatively on South African schools" (Jansen, 1999a:146). He believes that the language of the documentation is inaccessible, that there is no evidence to the linking of

curriculum to economic growth, and that the national government has designed a system which does not take into account the realities of the classrooms and teachers in South Africa. In addition, he points out that there is a contradiction in "specifying desired outcomes and using knowledge creatively" (Jansen, 1999a:150) and that teachers were not instrumental in the designing of policy guidelines. Finally, he states that the same set of specified outcomes could be very differently interpreted by different teachers, that OBE and it allied assessment policies are an administrative nightmare, that curriculum content has been "trivialised" and that sufficient financial resources are not available for its successful implementation

In conclusion, when examining the teaching and learning of Shape and Space there are a number of factors to consider. The teachers' content knowledge and their pedagogical knowledge will influence the way that activities are presented. These, in conjunction with the increased demands of the OBE curriculum, mean that the role of the teacher is a complex one where she must balance her gut feel of what is right for the children, with a solid understanding of the mathematical content being taught.

2.3.1 OBE and Numeracy

As stated in the introduction to the learning outcomes in the Department of Education (2002:10), the Foundation Phase focus for the study of Shape and Space, (LO3) states that: "Learners should handle objects and shapes, cut out and draw sketches, and describe them with appropriate and expanding vocabulary". This is further expanded in the document with six assessment standards for Grade R.

There are six assessment standards for this learning outcome in Grade R. Each one is only the minimum requirement for that grade. Each assessment standard

is packed with verbs indicating the kinds of processes the children must carry out, eg: "describe, sort and compare". (Department of Education, 2002:10)
AS 2: The learner describes, sorts and compares physical three-dimensional objects according to:

- size
- objects that roll
- objects that slide

This implies that teachers must design practical activities where learners have opportunities to:

- Describe a variety of three-dimensional objects using a range of size words, namely big, small, bigger than, smaller than, middle-sized, medium, smallest, biggest, largest etc. This in itself is a task that could be repeated often using an assortment of objects both natural and man-made, indoors and outdoors.

This is only one bullet of one assessment standard. One could continue unpacking each assessment standard in this way, thus providing a rich and mathematically sound curriculum which would provide the Grade R learners with a solid foundation on which to build Geometry concepts later on.

In addition, these assessment standards give no indication of the depth into which the teachers must go when dealing with each one.

In the next chapter, I will outline the research design used for this study and the methods used to attempt to search for answers to these critical questions.

CHAPTER 3: RESEARCH DESIGN

3.1 The Focus of the Research

The primary aim of this research was to conduct an investigation of the teaching and learning of geometry in the Reception Year. According to Leedy (1985:5) "research deals with the main problem through appropriate subproblems". Therefore, in response to the main research question of obtaining a snapshot view of the beliefs, practices and backgrounds of six Foundation Phase teachers teaching at six different schools in the Cape Town metropolitan area, several sub aims were identified.

- Teacher Education:
  To understand the impact of the study on Teacher Education, I thought that it would be important to observe closely the teaching methods used for shape and space activities in the Grade R classroom, so that Numeracy didactics can be brought in line with this. This was first briefly investigated via a questionnaire, and then followed up by on site visits to classrooms.
- OBE:
  With the advent of OBE, a scrutiny of the subject matter taught in the classrooms and the selection thereof, is essential to allow me to assess the impact that OBE has had on the teaching of numeracy, specifically Learning Outcome 3. This was done through the medium of teacher interviews and questionnaires, pursued and verified while closely observing the teacher presenting activities.
- Curriculum:
  As previously stated, the new curriculum has for the first time stated the content required to be taught to grade R learners. This content is considerably more than that previously by teachers taught to their pre-school learners. And it was important to ascertain whether teachers were

teaching age and curriculum appropriate content. This was accomplished by a questionnaire, and then validated via the classroom visits and a follow up interview immediately following the observed lesson.

- The learners:

  The teaching approaches selected for Grade R learners are many and diverse. Little is documented as to what constitutes "best practice" for the age-group. In order to come to this conclusion, it is important to ascertain the status quo in the classroom. This was achieved by an on site visit to observe the teacher presenting an activity, and further explored by the follow up interview directly after the lesson.

Following the structuring of the research in this way, an appropriate design emerged.

3.2 Research design

This investigation occurred within the qualitative research paradigm and assumed a case-study approach. A case study is defined by Yin (1989:23) in Rose (1991:197), as:

> "an empirical enquiry that investigates a contemporary phenomenon within its real life context; when – the boundaries between phenomenon and context are not clearly evident; and in which – multiple sources of evidence are used".

As the researcher is involved with pre-service teacher education of Foundation Phase (incorporating Reception Year) teachers, it is of specific interest to examine the nature of the teaching that occurs in the school situation. A case-study approach is best suited for this purpose. Through this scrutiny, a context - "aspects of the world as we observe or see it" (Dunne, 2004:2) - will be able to be outlined to the students when presenting didactic material to them. It will also allow for the tailoring of teaching experience-based tasks which are given to

students to practice the skills of teaching Numeracy, and specifically the concepts of Shape and Space. Once deductions have been made from the case studies, albeit through a small sample, some idea will be gained of the current practice of the teaching of space and shape concepts.

The predominant feature of this enquiry is that it is of a descriptive nature. It attempts to portray a picture of the teaching and learning of shape and space concepts to Reception year learners at a particular moment in time.

An empirical study, using ethnographic research and a case study approach was the mode selected. According to Mouton (2001), this is most suitable for qualitative studies that set out to intensively describe a small number of contexts.

Data collection included semi-structured interviews, classroom observations with accompanying field-notes, a questionnaire which probed the selection and use of teaching materials and teaching philosophy and follow-up interviews to further explore and reflect on issues arising from the activities presented. Several opportunities of one-on-one interactions with the researcher encouraged a close rapport to be built up between the teacher and the researcher. A small-scale investigation will attempt to achieve depth of knowledge about the teaching and learning of shape and space concepts in the Reception Year.

A case-study approach has been selected because by establishing a close rapport with the subjects being studied, intensive insight may be gained into some instances of the learning and teaching of shape and space. In addition, a case study approach will provide an opportunity for "testing theoretical propositions which the principle of qualitative selection of cases offers" (Rose, 1991:194). The theoretical framework according to Hiebert et al (1997) was initially used as the basis for the structured observation and the design of the semi-structured interview. This was later found to be unsuitable and extensive field notes of the classroom events provided rich data instead.

Runyan (1982) points out that while the case study method has been criticised for a lack of controls, for inadequate measurement of independent and dependent variables and for data being interpreted in an arbitrary manner, the richness of material cannot be obtained in any other way. He also notes that the case study is particularly useful for tasks such as describing an individual's experiences. In this study, the individual educator's response to the demands of developing concepts of shape and space in young children is crucial because of the small scale of the study.

Hitchcock and Hughes (1989) outline several steps necessary in the process of ethnographic fieldwork, namely to:

1. locate a field
2. manage entry
3. locate informants
4. develop field relations
5. collect data in the field
6. collect data outside the field , and
7. analyse the data

5.1.2 Locating the field (Site)

The Western Cape, where the research took place, is a large and diverse area. The following were taken into consideration when selecting sites for this research.

- The site should be easily accessible and close to the workplace of the researcher as the research was to be conducted during working hours.
- The schools selected should form part of the schools used to place pre-service teachers during their practical teaching experience. This would hopefully verify some of the claims made by students about the varying experiences they encountered in the schools.

- The selection should offer a range of teaching situations. Grade R classes could be attached to a primary school or a pre-school (which would include classes of 3 – 4 year old and 4 – 5 year old children).
- There should be a range of learners with respect to race, class and gender.
- The sites should reflect the variety of schools in the Western Cape, poorly, well resourced and different socio-economic groups.
- The selected schools should all be English medium.

A range of sites and samples were identified, through the assistance of the Early Learning Resource Unit, colleagues in the field, and a street map of greater Cape Town. A circle with a two kilometre radius was drawn in an area, and six sites within this radius were identified which would reflect the above criteria.

3.2.2 Managing entry

Permission was requested from the Western Cape Education Department's research director, and duly granted (See Appendix A). Letters to the school principals followed, and as these were all schools which had been previously used for teaching experience placements, all were very willing to grant permission for the research to take place in their schools. Schools were proud to have been selected and teachers made comments such as:

> "I will definitely put this on my CV"
> "What makes me so special; you know more than I do?"

3.2.3 Identifying the sample of teachers

Six different urban Reception Year teachers in the Western Cape were the subjects of the research. As a researcher, I believe that since the ECD field is a much under-researched area, an opening will be created by this small sample,

for further probing of the teaching and learning of shape and space concepts and other topics in the ECD field, in the South African context.

Six reception year teachers were selected using a quota sampling system to reflect diversity in several sectors of the ECD field,

- diversity of teacher identity (race, class and type of teacher training)
- a range of learners with respect to race, class and gender
- a variety of schools (poorly / well-resourced, socio-economic group differences and either attached to a primary school or not)

The biggest change that the RNCS produced is a set curriculum for the teaching of the three learning Programmes (Literacy, Numeracy and Life Skills) in the Reception Year. This is the first time that prescribed content with a structured set of assessment standards is in effect for early childhood teachers.

Added to the new curriculum demands, is the fact that the topic under discussion here is Numeracy, for which these teachers on their own admission received little or no preparation in their training. It is therefore understandable that the teachers were not keen to implement the new curriculum until they were actually forced to.

The Grade R year is a new dimension arising from the advent of OBE. When selecting a sample for the research, it was necessary to consider the aspect of the variety of teacher training backgrounds from which Grade R teachers are drawn. Historically, Grade R teachers come from a pre-school teacher-education background where the emphasis is not on a structured pre-determined curriculum, but on an emergent curriculum which follows up from spontaneous happenings in the playroom. Since Grade R has been incorporated into the GET (Grade R – 9) band, it now forms part of the Foundation phase and teachers are now trained to teach Grades R – 3 and receive a Bachelor of Education with Foundation Phase as their specialisation.

The teachers who were interviewed, were mostly from a pre-school teacher education background (Barkley House – 4 teachers, Primary School and Unisa Pre-Primary (1) and Educare (1) trained). Their teacher Education Programmes promoted learning through play, and formal teaching or presentation of a 'set curriculum', was frowned upon. So, for these teachers, the shift to a set of measurable standards, which have to be assessed and achieved by the end of the school year was something very new.

An interesting consideration to bear in mind, is the time frame in which the data collection took place. The data was collected from the six schools and teachers during the two month period April – May 2003. At this time, the Revised National Curriculum Statement (RNCS) had already been published, but the Western Cape Education Department (WCED) had not yet made it mandatory for teachers to implement this. Some Primary Schools had already taken steps to come to grips with this new curriculum and were using aspects of it in their weekly planning. Most schools, however, waited for the time when it was absolutely unavoidable, before implementing the RNCS.

Teachers had already been exposed to the philosophy of OBE through workshops held by the WCED. In addition, the WCED had promised training to accompany the roll out of the RNCS; so many teachers hoped that this would shed light on the curriculum and demystify it for them.

3.2.4 Developing Field Relations

Firstly, the research had to be motivated and this was a simple task. All teachers welcomed the fact that care was being taken to investigate their plight. The teachers' trust had to be gained. They were assured that confidentiality would be assured at all times, and that tape recordings would be returned to them when the research was completed. I already had a good rapport with most of the teachers, as I had encountered them previously when placing students in

schools. I ensured that all interviews and observations fitted in with the teachers' time schedules, so that minimal inconvenience would be experienced. On rare occasions, this meant that appointments had to be rescheduled.

It is important, when attempting a small-scale study of this nature, to ensure that what the teachers and learners do and say becomes the major focus of attention (Hitchcock and Hughes, 1989). When conducting exploratory research, it is essential to have a comfortable, non-threatening relationship with the subject. Many teachers had experienced the researcher as a student-evaluator, and it was paramount that this research did not simply become yet another "lesson evaluation". The initial encounter (pre-interview) with the teachers was informal, yet professional. In some cases, this meant that teachers were allowed to recount anecdotes to make them feel at ease with the process. At all times, subjects were brought back to the question. I considered the process to be a successful one as the teachers felt comfortable enough to express some of their deep concerns around the topic. The subjects themselves welcomed this research as they felt it would benefit them in the long term. By providing them with summaries of the findings and recommendations, they hoped that their teaching would improve.

The WCED were assured that they would also receive a copy of the final thesis.

3.3. Data Collection

With the above considerations regarding the aim and sub-aims in mind as well as the nature of the research, data collection consisted of several strands:

- A semi-structured pre-interview
- A structured questionnaire
- Lesson observations
- A follow-up interview

3.3.1 Pre-Interview

The pre-interview attempted to gain an insight into the reception year teacher's perceptions of the concepts of shape and space, which are required to be taught to the learners in her class. Teachers were asked their perceptions of best practice regarding shape and space and also what they learned about how to teach the topic during their teacher training. They were also questioned about their opinions of Curriculum 2005, their perceptions about the philosophy of OBE, and their knowledge of supporting documentation. An open-ended questionnaire was designed, which allowed for individual differences in responses. A certain degree of flexibility was required during interviews, so as not to detract from the exploratory nature of the study. Interviews were tape recorded and later transcribed, so that as much information as possible was captured. The full outline used for the interview is available in Appendix B. An appointment time was set up for the classroom observation and the questionnaire was given to the teachers.

3.3.2 Questionnaire

The questionnaire was designed to accompany and gain some insight into the planning of the lesson. Questions were asked about the selection of the topic and concepts to be presented to the researcher, and how the teacher came to that decision. Also, the teachers' ability to sequence geometry content was probed: teachers were asked what they taught before the chosen activity, and how they would follow up the concept in the next activity. I was also interested in the teachers' use of resources, and how they made their selection. The questionnaire was collected on the day of the observation and briefly scanned before the lesson was observed.

The full text of the questionnaire is available in Appendix C.

3.3.3 Classroom Observation

With the background knowledge gained in the interview and the questionnaire, I began the process of observing each teacher present a 20 minute shape and space activity. The lesson was pre-arranged so that the teacher prepared an activity specifically for the observation time. Sometimes, I would stay longer, to observe the children carrying out the creative task. I also took samples, where possible, of creative work done by the children, which linked to the shape and space activity.

Initially an observation schedule was designed, but discarded after the first lesson was observed as it was not practical, and was found to be restricting. As this research was exploratory, I decided to take field notes instead. In this way, I was able to capture most of the relevant dialogue between teachers and learners. Here, the subjectivity has been noted.

3.3.4 Post interview

The follow-up interview was conducted directly after the observed activity for clarification purposes. it was necessary for validation purposes to ensure that the researcher's perceptions regarding aspects of the incidents observed were in keeping with the teacher's goals. Again, this was a semi-structured interview. (See Appendix D) The teachers were asked reflective questions relating to pedagogy: what the highlight of the lesson was in their opinion and what they thought were good and poor examples of how shape and space should be taught. I also asked what aspects of the lesson they were particularly pleased and displeased with, and asked them to reflect on any difficulties they experienced. This was the last opportunity for the subjects to comment on any relevant aspects of shape and space teaching. Field notes were taken.

In the following Chapter, I will present the findings obtained through the various modes of research.

CHAPTER 4: DATA OBTAINED

This chapter outlines the stories of the six teachers who were the subjects of this survey. Here I will report on the various forms of data collected in an attempt to introduce these educators and their learning philosophies, their thoughts on the numeracy curriculum and Outcomes Based education, and their best practice presented for observation. I include comments on a joint reflection after the lesson.

4.1 Teacher A

4.1.1 Background

I began this research with a teacher whose Grade R class was attached to a Primary School. She is 50 years old and has over 27 years of teaching experience in various grades in the primary school. (Grades R – 7) Her training includes a Primary Diploma, followed many years later by a UNISA Pre-School Diploma. She could not remember any mathematics being part of the pre-school course and said she would need to check on her diploma as to whether or not there was anything of that nature included.

4.1.2 Pre-Interview

During the interview, she stated that the best way children learn the concept of Shape and Space was incidentally. She gave various examples, such as learning through puzzle building, outdoor play on the jungle gym and block play. Concepts that she thought were best learned through playing with wooden and Lego blocks were, "what fits together", "what balances" and the concepts of "bigger and smaller". She found these concepts to be easily illustrated in the development of the children's' block play, which usually started at the beginning of the year by being "flat" and then later developed into structures which grew upwards and

included aspects of balancing. These manifestations allowed her to judge the child's maturity level.

She also found educational games and puzzles to be very useful as they were "multi- purpose' and many different concepts could be learned while playing with them. I asked teacher A to explain how children could learn concepts incidentally. She again referred to the blocks and said that through trial and error, children would learn that "two triangles make a square". If the teacher was nearby, she would mediate this, but mostly, the children would "work it out for themselves." She said that she noticed that block play was mostly chosen by the boys. Girls seldom played there. The teacher would observe where possible, so that she could assess the children's ability. She claimed to know the children and their abilities well. She would also note which children avoided certain tasks, as this was an indication for her that they were not confident in this area.

Another way in which this teacher considered that children learned concepts of Shape and Space was through their own bodies. Matching their own body shapes to those of a partner, (movement which teaches space relations – "through the hoop, over the hoop" etc), and making ropes into shapes such as triangles and circles were some of the examples given. If children had poor spatial concepts, they would get stuck in small spaces on the outdoor equipment.

She noted that certain children could not grasp concepts the first time, so repetition was necessary. Children who were already familiar with these concepts would extend the task themselves, for example, when being asked to jump over a hoop, the brighter children would do six varying jumps. The teacher would then draw the rest of the class' attention to this and give them, too, an opportunity to try these variations. No child would be forced to do this as in her opinion it was not "age appropriate".

Creative art activities are also used to teach Shape and Space concepts. One example the teacher suggested was to use a box of pre-cut paper shapes, and instruct the children to choose shapes and make a collage. Most children made houses – this was considered an indication of a low level of ability. Some created boats and other shapes; this showed that they were more advanced. Children were given the freedom to make whatever they wanted, and the teacher would comment on the "more exotic" ones. This would hopefully motivate the other, less creative learners. The teacher would comment encouragingly: "Look it is amazing how you can use a triangle to make a boat".

The interview then proceeded to inquire about the demands of Curriculum 2005. Teacher A said that in pre-primary, little had changed in this respect as their method of teaching had always been "hands on" and creative. The given bench marks were, in her opinion, "lower than what was previously required". (This discrepancy will be referred to in a later analysis) As far as the difference in age of Grade R children, she had not needed to make any adjustments, as they were still going into Grade 1 and therefore no more teaching was needed.

She admitted that most children came to school knowing their basic shapes, and then she would "build on that". It was difficult to ascertain exactly how she did this. Again she mentioned "two triangles make a square" and "two squares make a rectangle", but this was something the children would do by themselves. She said it was important to put out advanced games for these children, as they themselves would take the concepts further. She did not believe that Shape and Space concepts should be formally taught as these were all "part of their world". Children also recognized shapes in the letters of their names and sometimes remarked on this.

She admitted to the fact that maths at school was "a nightmare' for her, but said that what she taught was "not maths maths". For her, these were very separate.

I made a follow-up appointment to see a Shape and Space activity, and this occurred two days later. A preliminary questionnaire which included data about the planning for the lesson was left with the teacher for her to complete in her own time.

4.1.3 Questionnaire

Teacher A stated in response to the question regarding the topic to be taught, that as it was the beginning of the term, she would assess the learners' shape knowledge (shape names and size). She would also assess their understanding of putting shapes together. She chose to use pre-cut paper shapes, which the children then used to make a picture (Creative Art activity – collage). Her theme for the week was colour. She hoped that through the children's' experimentation with various shapes, she could "make many observations on which I can build".

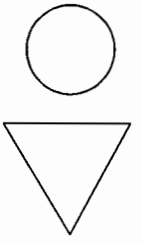
4.1.4 Lesson Observation

Teacher A chose to present an activity during the morning ring, which would provide the background for one of the creative activities later on. The introduction was a counting rhyme accompanied by a finger play. The geometric concept dealt with was a revision of the shape names, using two-dimensional wooden shapes for questioning purposes. They were a circle, square, rectangle and equilateral triangle. This was a teacher-directed lesson with closed questions by the teacher, and individual children being called upon to give responses.

In the questionnaire, the teacher said that the concepts to be highlighted were:

> "Basic shape names, size. Shape awareness and shapes used and put together to make pictures."

During the lesson, teacher A asked questions around certain shapes, and then she would put two shapes together, e.g.:



The children would suggest possibilities for which objects these could be.

Responses such as an ice cream or a person would be offered. The teacher continued this with a variety of shapes. Children were then placed in groups at a table where there were a variety of the shapes previously discussed, and they were asked to make a picture. They were encouraged to use scissors to cut the shapes, so that "you can make the shape smaller or change the shape".

The teacher mediated the learning at the table by asking what the various shapes or shape combinations suggested to the children. This is part of one of the assessment standards for Grade 1, namely: "The learner recognizes and names two-dimensional shapes in pictures" (Department of Education, 2002:26).

Most children made a house in their picture using a square, triangle for roof and rectangle for chimney. There were a few interesting variations which were praised by the teacher.

4.1.5 Post Interview

I then interviewed the teacher directly after the lesson. Highlights which she noted were:

- the children's ability to concentrate for a surprising length of time, (Twice mentioned),

- one particular child's progress in his ability to compose a picture,
- the fact that the children knew their basic shapes
- the children's choice to experiment with scissors to alter the given cut-out shapes, and
- the fact that some children recognized the shape when it was rotated.

She believed that her ability to question, (What is this shape called?) and elicit the children's ideas of possibilities for combining shapes, were good examples of how Shape and Space should be taught. She also noted that one instance, where she instructed a child to use a circle in the middle of his flower, was a poor didactical example. Spoon feeding the children in this way was stressful for the children.

Throughout the data collection of the first subject, this teacher went to great lengths to outline how well she knew the children's abilities, and how she constantly strove to assess their knowledge.

4.2 Teacher B

4.2.1 Background

This thirty-something teacher at the second school, a large, dedicated pre-school has a four-year teaching diploma from Barkley House and has been teaching in the field of pre-primary education for ten years. She admitted to enjoying maths as a subject at school. Teacher B responded in a confident, animated way to the questions posed, and visibly enjoyed the discussion.

4.2.2 Pre-Interview

Teacher B categorically stated that children best learn concepts of Shape and Space through their own bodies. Using, for example, four children to make a

square and then discussing the properties of a square would lead to discussion of the properties of shape. This would link to the visual representation which they themselves had made. Identifying shapes in the environment would also be a good way to learn about shape, as the children have such a keen visual sense.

Creative Art activities using shaped paper could also lead to a shape discussion. She stressed the importance of integrating learning. Repetition at various times during the day, such as during music and movement time, would help to reinforce the concepts to be taught. Using spatial relationship concepts during movement time, such as physically jumping over, into, and out of hoops would be a useful shape activity. The environment at this particular school was well designed for this sort of integrated teaching. Each piece of equipment that was in the school was particularly designed with a learning objective in mind. She emphasized the importance of three dimensional objects for this age group, as they cannot yet think abstractly.

She realised that many children already knew the names of the basic shapes, and that extension of concepts was very important for these learners. Vocabulary such as corners, spheres, hexagons and trapeziums were some of the words mentioned.

Another powerful, practical, three-dimensional and age-appropriate creative art activity which she used to teach space and shape concepts was box construction. A variety of used cereal boxes, toilet rolls and other three dimensional waste material is set out. The children then select from the boxes, and glue them together to make a construction. A camera and a gun were some examples of the children's handiwork. Children learned that "things can have body and volume". Children would be given a great deal of freedom, but some mediation would take place in the form of a discussion about how and what they made. She did find it necessary to give them the beginnings of an idea, for example bending a flat piece of cardboard, so that the children could explore that

idea further. This medium was particularly successful since "children are so creative. We are very limited in our thinking... Their minds are so free". She drew attention to the fact that at their school, children were given the opportunity to "experiment and to mess". This resulted in the end product being less stereotypical than "some children who come from outside schools, they come in and they are very rigid". She then added: "For us, the process is more important than the product".

She believed that sometimes it was necessary to break pictures down into shapes to help the less confident learners to draw. A child who wanted to draw a helicopter and did not know how to go about it, for example, would be helped by the teacher to think about the shapes of the blades (rectangular) and the body (oval) so that he could proceed.

Collages, too were useful for picture-making and through this, children would learn indirectly what shapes can do, and how shapes fit together to make other shapes. ("You can take two triangles and fit them together and you can make a diamond")

Games such as *Tangram* were something that supported the learning of shape concepts, and "turning the shapes around teaches children that shapes change, and things are not what they seem".

In her classroom, block play was a free-choice activity, mostly selected by the boys. She felt that the boys' exposure to three dimensional activities was possibly the reason why "boys are so good at the architectural side of things".

In response to questions about Outcomes-Based Education, Teacher B felt that the demands had not necessitated many changes in her teaching, as it was "pretty much what we do as pre-primary teachers anyway". For her, OBE was mostly about discussing things, working in groups, the ability to problem solve,

and "asking open-ended questions". This was easy for a pre-primary to implement. The terminology used in OBE was unfamiliar, and teachers would have to get used to that.

The teacher said that in the pre-primary there was no specific curriculum to follow. Teaching was very flexible and allowed for children to enter on different levels.

4.2.3 Questionnaire

In her planning for the Shape and Space activity to be presented, Teacher B wanted to teach children the more advanced properties of shapes, namely the names, sides and angles. She specifically chose to use:

a. three dimensional wooden shapes because they offered a concrete example whereby children could visualise and internalise concepts
b. the body, as she believed this was the foundation to all learning.

4.2.4 Lesson Observation

This activity also took place during morning ring, with wooden shapes, as with teacher A's lesson. The teacher used vocabulary such as "corners" and the children volunteered what they could make with the various shapes. For example a rectangle could be a door; a circle could be a sun or a pool.

Sticks were put out (two short and two longer) and the learners were asked to make shapes with them. The criterion was that they had to use all of them. Individual children came up to the centre of the circle and made the shape. Teacher B would then question them about it. e.g.:

T: What shape could you make using all of these?
CH: (in unison) A square, a rectangle.
A child then makes a rectangle.
T: Is it a square or a rectangle?
CH: (Again in unison, difficult to make out what hey are saying) A rectangle, a square.
T: Why?
T: Because it has long sides and short sides.
This was repeated with three sticks
A paper folding activity followed. The teacher instructed the children how to make a hat from a square of paper. Children were expected to watch what the teacher did. She asked questions as she went along, about corners, and the name of the shape which resulted from the folding process. This was followed by A short poem was taught:

My hat has three corners
Three corners has my hat
And had it not three corners
It would not be my hat

One of the creative activities would be the children making the hat on their own and decorating it.

A second activity involving shape was the shaping of hot cross buns from dough as it was Easter time. After this, the teacher gave several children an opportunity to guess the names of the shapes that she would trace onto their backs. As she traced the shape, she would verbalise. For example while tracing a rectangle she would say:"Long side, short side, long side, short side". Lastly, children made various shapes using their fingers.

4.2.5 Post interview

During the follow up interview, teacher B said that the highlight of the lesson was the fact that the children could make shapes with sticks, as they had not done that before. She was also particularly pleased that the children managed to make the hat, some even helping others who were struggling. This will be discussed later on in this document, as this was further mediated by the teacher in small groups. The teacher reported that there were instances during the lesson where she deliberately did not call upon certain learners to respond to questions as they were insecure with the concepts being taught. "I chose the right people, who know it well".

4.3 Teacher C

4.3.1 Background

This is a small, independent Christian primary school, with a single stream per grade and a group of 26 Grade R learners. The classroom was small and less resourced than the other rooms visited. Teacher C is the least qualified academically of all the teachers in the sample. She has an Educare (two year) diploma from a private college, and has a total of eight years experience in Early Childhood Education, varying in ages from two to six years. She admitted to the fact that she did not like maths at school as nobody took the trouble to explain concepts properly to her. In her teacher-training, only a little number work was covered, and the importance of counting was stressed. She agreed that her training was lacking: "I find there is (sic) a lot of things that the other teachers speak about and that maybe I didn't learn at Cape College. So I do think I would need an extra two years for more information. Personally I would like to do it".

4.3.2 Pre-Interview

During the interview, she explained that she was very nervous, and this was clear through her barrage of responses, especially to the first question. However, on examining the transcripts, her answers were mostly quite short and required some prompting from me. Her candour about the limitations of her knowledge was clear. She often began her responses with "To be honest with you..." She did not continue with mathematics, and when asked what Geometry was for her, she responded: "I don't know what Geometry is, I never did maths".

Her response to the first question about how children best learn Shape and Space concepts was very confused, and many aspects were stated. Firstly, that the teacher needed to do "practical things with them". She elaborated that they learn through their bodies. She added that if learners struggled, for example, with triangles, one of their peers would help them. She said that children listened more readily to each other, and that leadership qualities could be developed. "Children usually figure it out for themselves", she said. "Then sometimes I show them how to write it in the sand". She explained that she would draw a shape on the board, ask how many sides there were, and then the children could do it with their bodies. I probed to find out what spatial concepts she expected children to learn through their bodies and she responded that she did not know.

She continued, by saying that shapes were a part of everyday life, and it was important to draw children's attention to this in other aspects of learning. A box of plastic two-dimensional shapes was also a useful tool, as children could match these to a picture. Blocks were available, but she did not use these, as she felt that they were more appropriate for younger learners.

Regarding the OBE curriculum, she replied defensively that she had not attended "the college" so she did not have much knowledge of it. She felt that she should read it at some stage in case she was questioned about it, as I was doing. Her

colleagues had reported that the content of the new curriculum was quite similar, only that it was worded differently. She felt that from hearsay, she had deduced that OBE was about developing children holistically and that she definitely developed that whole child in her teaching.

I later probed her as to how she handled those children who already knew their basic shapes. "Well, they drive me mad" she responded. She used their knowledge to help children who were unsure of concepts, and then she consulted with the Grade 1 teacher to see get some more advanced games which they could complete on their own. Slower children would need to be helped on their own. They would often copy the other children's answers, perhaps out of fear of giving the incorrect response.

She also added that having her own children has changed the way she teaches. She has become softer and less cold with the children.

This was the oldest group of learners that she had ever taught. This meant that she concentrated less on playing, and more on structured activities. In her opinion, children these days were more advanced, as the influence of television had given them access to more information.

The last types of Shape and Space activities which she mentioned were peg boards and making shapes with play dough. Some probing was needed before she could tell me how she mediated the learning, but during these activities, the teacher's role was, in her opinion, to help the children "get it right".

5.1.2 Questionnaire

Teacher C responded to the questionnaire very briefly, saying that she decided to work with basic shapes as the children needed "lots of practice with this". She wanted the children to match shapes and learn about size. She had already

introduced her class to the circle, square, rectangle and said "they know a little bit about the triangle". The vocabulary that was to be developed in the lesson was shape and size.

4.3.4 Lesson Observation

A lesson was presented to the whole class, all seated in a circle while the teacher questioned them. Clues were given, and children were expected to identify the names of basic shapes (circle, triangle, square). This was repeated until she was satisfied that the children were familiar with the shape names: "You are quite sure now..." She continued by holding up plastic shapes, and asking the children to find something in the classroom that looked similar. Many children referred to the alphabet chart e.g. the triangle in the capital A and the circle formed by the O. This was repeated many times, with a great deal of emphasis being placed on the correct answer. She replied "well done" several times when the children found a matching object.

The third activity required the children to make shapes with their bodies. For example, three children were called to the centre of the circle and asked to make a triangle. They lay flat on the floor and tried to represent the shape. Their peers were called upon to assist if they were struggling. This was repeated with a rectangle and lastly a circle.

Confusion arose when she called six children up to make a rectangle. The other children became involved in where their peers should lie to make the shape. Children struggled because of the different heights of the children. The counting of the sides caused confusion, as they counted the bodies (six for a rectangle). The teacher told them to say that the two children would be one side.

The final activity involved two children lying down and other children tracing around the perimeter of the body with crayons on the one body, and packing out

shapes around the outline of the other child's body. This was difficult for the children. They did not trace the entire outline as the teacher had expected, merely creating a new shape around the body with the crayons This did not seem to be linked to anything that had been done previously, and when I discussed this after the lesson, she said that she wanted the children to understand that:

- not everyone's body is the same size, and
- that one child was taller than the other.

She asked simple questions, which elicited chorus responses from the group, about which child was bigger, taller, and which one looked smaller. These two closed questions ended the activity.

4.3.5 Post Interview

Reflecting on the lesson together afterwards, Teacher C found the final activity to be the highlight of the session, because "the children enjoyed it so much". She decided that it could have been more successful if the group had been smaller. She commented more than once that the lesson could have been more successful if the children had been less restless.

4.4 Teacher D

4.4.1 Background

Teacher D was the youngest (26) and least experienced of all the teachers in the sample. She qualified in the last four years with a four year higher diploma in pre-primary education from the former Barkley House Teacher's College. Her training was mostly school-based, and in her words: (Numeracy), "at college? Not really. ...I found that I didn't learn that much." There were no numeracy notes to fall back on and her primary resource was an 'Early learning pack.' She took

Mathematics as a subject at school, but only enjoyed working with numbers, not Geometry.

4.4.2 Pre-Interview

Teacher D began her responses by saying that children learn Shape and Space best through "hands-on" activities. She gave examples such as working with string, sticks and blocks. She also mentioned spatial orientation (localizing) games such as placing a shape in front of and behind them. She mentioned that blocks were also incorporated into numeracy, for colour recognition and counting. Wooden blocks used for construction, were an effective means of incorporating Shape and Space concepts. Using their bodies during movement lessons, the children could also experience walking around a shape. She referred to box construction, which was a creative activity that incorporated Shape and Space concepts, but when I probed, she focused more on the achievement of an end product: ie "you use wool for hair, this is a pipe cleaner, it can be a smile."

It was apparent to her that most children already knew the circle and square shape, but many were still struggling to know the names of the triangle and rectangle. It was important to her that children were able to work and develop at their own pace, as this was what OBE was about.

I then questioned her about extending children who already knew certain concepts, eg basic shape names. She stated that there were activities in books that they could do, such as the matching of two-dimensional shapes. These children would be more creative when making a collage or drawing for instance and could talk about the shapes they had used by name. This was her idea of extension of a concept.

Moving on to thoughts about OBE, Teacher D said that she was already "used to the swing of OBE" from her training, so when Curriculum 2005 was introduced,

she simply continued with that she was already doing in her classroom, and "I wasn't angry. I wasn't excited. It was just - the Department's (WCED) doing something new again". She had already been through the document file, and had gleaned that the basic requirements were that children have to work together, as a group, and that they develop at their own pace. She said that she received most of her ideas for lessons from books an from co-planning with the other Grade R teacher.

Teacher D stressed the importance of Shape and Space vocabulary for communication with the teacher, especially in Grade 1.eg: "I must build that puzzle on the table." (not on the floor)

During the rest of the interview, she described many different anecdotal incidents that indicated what she would say to the children about shape. She often strayed from the point and would relate other successful activities which she had completed with her class. She also mentioned that copying shapes onto a peg-board was a useful activity, but could not express how she would do this beyond saying that she would guide the children.

4.4.3 Questionnaire

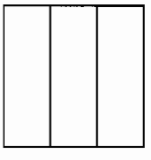
In her planning for the lesson, she decided to work with the square, triangle and rectangle shape because it fitted in well with the current theme of houses. She needed to repeat these basic shapes for the children who were still struggling. Vocabulary to be reinforced was: right and left, underneath, side, how many on the side, how many all together and take away. (The last three are not specifically Shape and Space words.)

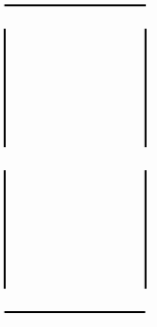
4.4.4 Lesson Observation

The lesson itself was a whole class lesson. The teacher began by saying to me: "I am going to be using counting sticks for my lesson, is that all right?" Each child was given five sticks. (very time consuming) A counting rhyme and activity followed. Then children were asked to make a triangle using the sticks. Children were asked how many sticks they used and what the shape reminded them of. Answers were a cap, a hat, a roof. Further question followed such as how many sides, were they even or uneven, and what kind of sides they were. Children did not understand the last question, and the teacher clarified by asking:"Are they the same, or not the same?"

They then built a square. Similar question were asked. The rectangle proved to be difficult. Children were hesitant. The teacher reassured them by saying that they could build the rectangle any way they wanted to. As they continued to struggle, the teacher said:

"Two sides are even and two sides are uneven." Again she tried to help: "Two long sides and two short sides." These are some examples of what the children made, as they tried to use all the sticks:





Children then counted how many sticks they used and represented this with their fingers. The teacher asked them what the shape looked like. The response was a door. Next, children were required to make a house with the sticks. They had to

identify the shape of the roof . A child responded that it was a triangle. Teacher D then said:

"He said it is shaped like a triangle. Is he right?" "Yes" was the chorus response.

The next question puzzled both me and the children: "Why is it shaped like a triangle?" There was silence, and the teacher left that question unanswered and proceeded to count the number of sticks used for the roof, and then to identify the square shape. Some more work with the sticks followed, counting, taking one away and adding one.

4.4.5 Post interview

In the follow-up discussion, Teacher D said that she considered the counting of the sticks to be a highlight of the lesson. In addition, she was particularly pleased that the children grasped the fact that three sticks were required for a triangle. The most difficult part of the lesson for her was "talking". She also noted that if children did not get the answer right the first time, it was necessary to change the way she asked the question. She also added that she could have used "three-dimensional movement" more in the lesson. As we were discussing the lesson, a colleague from the adjoining classroom and said:

"You are really putting Teacher D under pressure today." Immediately I was reminded of what a stressful situation this was for this teacher and the others in the sample. This could have a strong impact on the way in which the teachers conducted the lesson while a stranger was present.

4.5 Teacher E

4.5.1 Background

This teacher, who is in her forties, trained for three years at the former Barkley House Teacher's College. She had a ten year break after ten years of teaching, to raise a family and has since resumed for the past four years. She recalled positive experiences towards mathematics at school and stressed the importance of mathematics for developing logic.

4.5.2 Pre-Interview

When I first entered her classroom to interview her, I was struck by the dull appearance and rather bare walls, and the little work displayed was an array of stereotypical photocopied Easter bunny pictures. Initially in the interview, she was softly spoken and her responses to the questions brief. She relaxed later in the interview and was able to elaborate on her answers.

Again, the way in which the teacher thought that children best learned Shape and Space concepts was through physical experience. By this she meant "concrete materials, games, and anything that involves them practically". She added that comparing geometric shapes to the shapes of objects in the environment was something that kept children's interest and helped them to learn quickly. Moving around was also important, such as "when the music stops all the girls must go to the square and the boys to the triangle".

Perceptual games such as *Brainy blocks* and *Magic mosaics* or a game where children used a 'feely bag' to identify the shapes using their tactile sense could be used either by the children on their own, or in a teacher-mediated activity. This would help children to learn about subtle differences in shape, eg between a square and a rectangle.

Making pictures on a page using shapes was also useful, though not as effective as handling the three dimensional object or shape, as "paper work would be done afterwards". She could then assess children's spatial ability by the level of creativity in their arrangement, and the planning and arrangement they used. A child who would make a stereotypical house, using a square, triangle and rectangle, and would not experiment with other shapes was limited in their spatial development.

After an initial class discussion about three dimensional forms such as cylinders, she would then put out a variety of cylinders for the children to use in a construction activity. She added that it was important to leave this activity open-ended, so that the children could be creative.

Blocks and other construction materials such as *Lasy* and *Lego* were available for the children. She said that they could learn that "two triangles, depending on the way that it is cut, can make a rectangle or a square, or they learn how to fit two smaller blocks to make on big block". This was accomplished through experimentation and copying each other. It was easy to 'see' which children had consolidated concepts such as balance if their constructions were steady.

I was interested in how she dealt with children who came to school already knowing their basic shapes. She said that was not a problem as the input they received from her would reinforce this. They would "pick up new ideas" through experimentation, such as "oh look, I put these two together and it has made... like a diamond or whatever".

Spatial relationship concepts would best be learned during music or movement activities. She gave the example of "stand inside the hoop, put the hoop above you", etc. She stressed the significance of being able to master Shape and Space concepts when it came to reading and writing. Essential concepts for Reading and Writing are, using the correct reading direction, i.e. reading from left

to right and also being able to write their letters and numbers facing the correct way.

Peg boards were a very good spatial activity too. She could assess a child's ability to sequence, cross the midline and the skill of positioning from observing them complete simple pattern and shape copying tasks. She mentioned that children who had difficulty with these concepts would simply avoid these tasks unless encouraged.

Moving on to thoughts about Curriculum 2005 and OBE, she had not had a chance to go through the documents yet, and she felt quite angry at the Education Department for "chopping and changing". She also added that in her opinion, she was already fulfilling the requirements for OBE. Curriculum 2005 called for the use of practical work, and this was how she taught.

4.5.3 Questionnaire

Her pre-lesson planning indicated that the topic of the activity would be triangles. She wanted the children to be able to recognise and label a triangle, and know about its properties and the fact that they are all triangles because they have three corners. She also wanted to extend their knowledge to include a closer observation of whether all sides were the same and for the learners to experiment with placing triangles in relation to each other. Particular attention would be given to the vocabulary corner, point, tri, three and size words: big, small, thin, fat.

4.5.4 Lesson Observation

Field notes indicate the following at the start of the lesson itself: "Teacher takes a long time to get going, collects posters and shapes, reshuffles children around and then begins". The lesson itself was a whole class activity where the teacher

began by putting up a poster and revising the names: sphere, cube, cuboid, and cylinder. I was immediately extremely interested as this was the first time I had seen these words mentioned in a pre-primary class. The topic of triangles was then explored. By focusing only on one shape, consolidating and extending this, Teacher D managed to give the children may different points to think about.

These children had the freedom to speak out, there was little chorus answering, and the teacher showed encouragement without giving the children the answers. This made the children participate comfortably, without the focus being on the correct answer only. My field notes also indicate that the teacher gave the children time to think about answers and did not insist on a response right away. She also boosted their confidence, using phrases such as, ""now you see you can do it now" and "can you see how she has been thinking and made a different shape?" These and other such comments helped to keep the children interested, and motivated.

I have described this lesson in terms of several pieces of dialogue as it was a most unexpected flow of conversation which most clearly portrays the quality of teaching which occurred.

T: Can you tell me how we know a shape is a triangle?
CH A: Other stuff doesn't have three points.
CH B: And it is straight.
T: At the bottom you mean.
CH: Some other shapes do have three points.
T: Would it be a triangle?
CH A: Other shapes have five points and four points, a triangle has three points.
CH B: What about a beehive shape?
T: A hexagon. (T spends some time talking about the number of sides, where we find this shape)
CH C: Most shapes have straight sides

(Not sure whether the teacher heard this)

CH D: Triangles have skew sides.

T: They are sloping.

The teacher then showed the children a variety of cardboard triangles.

T: Are they all exactly the same?

CH E: No

CH F: Some are and some are not.

T: Are they all triangles?

CH G: No.

CH H: They are all triangles.

T: Look, here is a big fat one, this one is thinner.

CH: Yes.

T: How many points?

CH: Three.

T: How many sides?

CH: Three.

T: So it doesn't matter how big or how small or how fat or how thin, they are all triangles.

4.5.5 Post interview

When we reflected together on this lesson, teacher E said that the highlight of the activity was the use of concrete and three-dimensional apparatus. She felt positive about the way she had got the children involved, and added that a little demonstration by the teacher was beneficial.

As I left, Teacher E thanked me and admitted that this was a rather nerve wracking experience for her as she was not sure how the children would react. She then added that the session was good for her because: "You know, you do these things for so many years and now you have to think about why you do them...like I had to decide what I wanted the children to know. After a while it

becomes automatic – you just do it without thinking. So this made me use my brains!"

4.6 Teacher F

4.6.1 Background

Teacher F's class was one of two to be found at a primary school in the selected area. Her three-year diploma from Barkley House was obtained at a similar time to that of Teacher E. She has 20 years of teaching experience. During her teacher training, they did no mathematics at all. She was one of the few students had maths as a matric subject, however, but she reported that this did not help or influence the way she taught the children at all. During her interview, she offered minimal biographical information and was not very keen to answer questions.

4.6.2 Pre-Interview

When asked about her theories of how children best learn about Shape and Space, she answered very quickly and emphatically that children needed to experience it themselves through movement and their own bodies, not just through hearing. She then hurriedly added: "So do you want me to launch into the various activities or not yet?" I further explored her previous response and she explained that children could lie down and make a triangle with their bodies, or use arms to make a circle. Spatially, children were taught to use space during a music lesson by having "this imaginary circle to walk around the circumference of and so they get used to that. So those are our boundaries. We walk them around the perimeter of the school...and we say this is where you may not cross over". The teacher also mentioned that "we do a lot of brain gym and ... encouraging the two sides of their body to work together and just constant practice." Brain gym activities were used to encourage the two hemispheres of the brain to work together.

I asked for any further examples of activities which could be used to teach the concept, she stated that children were introduced to spatial relationships by crawling over and under a bench.

Returning to shape activities, she mentioned creative art activities as one of the fundamental ways of learning about shape. Cutting out shapes and building a picture with them would help them to learn the square, the triangle, the circle, rectangle and semicircle. Also, making a collage from pre-cut shapes, bottle tops and different fabrics and textures would be something they enjoyed and could encourage creativity. Sometimes children would be encouraged to draw their own shapes for use in a collage. These creative art activities would follow a morning ring discussion about the concept.

Later the children would learn the shapes: diamond, hexagon, octagon, sphere and cylinder. Even later, prism and cube would be introduced. She mentioned that during morning ring she encouraged the children to "put up their hands so that they are not all shouting at once, even from age 5 to 6".

Identifying shapes in the classroom environment was an activity which she would do during morning ring.

She kept a constant assessment of whether each child could recognise and discriminate between shapes and colours. Each morning before school the children had to do a perceptual game, e.g. shapes and colours, puzzles or brainy blocks. If they struggled to recognise shapes, the children would avoid playing with the games. For this reason completion of a game would be recorded with a star on a special card and children were rewarded at the end of the term with a chocolate. The teacher felt that "lots of repetition and further extending were needed for children who had difficulty with Shape and Space concepts".

I asked the teacher to elaborate on the concept of "extending". She became quite flustered, and said: "If you see that they are lying down on the ground then just encourage them to think and say you can use all this space around you. This is difficult, especially on a Thursday afternoon". I encouraged her to continue, by saying that I was interested in what she thought, as different people prioritised different things. I moved on to the use of construction activities.

Construction activities were useful for planning and executing an idea. During block play, children also learned about size, balance and weights, shapes and different heights (longer, shorter, comparison). Other commercial sets such as *Geostruct*, *Lasy* and *Junior Mechano* were also beneficial. Box construction from waste materials stimulated children to think. She would lay out the waste materials in an interesting way, for example building them up into various shapes. Children would then have to plan ways in which they could anchor one box to another. She would observe the learners while they were working and "...if I overhear one child speaking to another and it is an important concept to explain, I would encourage that and say, well done Emily you have thought about something. Can you share that with your friends?"

Peg boards with graded activity cards which children could copy, were important for "spatial positioning, colour concept, number concept and visual awareness", so this is often set out and encouraged.

Regarding OBE and the new curriculum, Teacher F spoke hesitatingly: "Well I find it quite...It is a little bit...It is much better laid out at the moment but it is still a little bit vague. I think it gives you the basis to go... the very basics". She said that it was a good guideline, but at their school, they could go beyond those requirements, as the children in School VI came from fairly good homes. Her understanding of the philosophy of OBE was that it allowed for different backgrounds, and levels of development. There was more emphasis on learning and self-expression. This meant that she had to change her teaching completely,

by documenting her planning and assessments. More needed to be taught and educators were expected to be much more goal directed.

4.6.3 Questionnaire

In the questionnaire, she said that the children had already learned and reinforced the basic shapes; circle, square, rectangle. semi-circle, triangle, oval and their forms (sic), e.g. do they have straight sides, corners etc. During the lesson, she wanted to highlight the shape concepts square, triangle, rectangle, circle, oval and semi-circle, together with the awareness of the vocabulary: curved sides, straight edges, corners and the names of musical instruments and their corresponding shapes. She mentioned that it had been difficult to tie in 'shape and form' with the current theme in the classroom.

4.6.4 Lesson observation

I eventually observed the lesson, after it had been rescheduled three times. The teacher was seated with her back to me, and then changed position so that she could see me. She took out some large foam shapes and asked:

T: What shape is this?
Ch: (chorus) A circle.
T: What colour is it?
Ch: (chorus) Yellow.
T: That's right. *Teacher looks up to make eye contact with me.*
T: I want you to use the rope and make a great big circle
Ch A : Oh no, not again.
T: Stand if you want.
Ch B: No I don't want to.
The child pulls the rope around and grunts.
T: Think about the sides, are they straight?

Are they curved?
Does it stop somewhere or do we have a gap?
Where does it stop?
Ch: Where you start.
T: Now lead your friends around and balance around the circle.
The children began to be more animated. Child A commented: "This is cool. This is easier than I thought."

Various shapes (oval, square, rectangle, diamond) were used, with the teacher's response each time being: "That's right". Certain properties were pointed out. For example, when discussing the square:

T: How many sides?
CH: (chorus) Three.
T: Let's count again.
Ch: (chorus) Four.
T: What about corners?
What are these things?
Ch: Points.
T: When you go to big school and learn maths, we call these angles. *Teacher laughs.*

Selected children were then asked to throw a coloured bean bag on to the matching colour shape.

Then musical instruments were introduced: tambourine chime bar, triangle and maracas. Children were asked to look at each one carefully in turn and identify its shape. The foam shapes were then matched to the instrument's shape. Lastly the teacher played each of the instruments in turn behind a screen and learners had to identify it by pointing to its matching shape. Children then returned to their tables in groups to complete a) a shape worksheet involving tracing over and

copying the four basic shapes, b) a collage involving pre-cut shapes, and c) a box construction where they were required to make a musical instrument.

4.6.4 Post interview

After the session, the teacher could not really identify a highlight of the lesson, as she said it contained little new knowledge, they were just reinforcing what they already knew. She thought that their auditory skills were "very good". She felt that the activity involving matching ideas of the shape to an instrument was a useful example as it was different. On reflection, she added that the lesson should have been more challenging, perhaps by using more complex shapes. She also commented that it was particularly difficult to teach the whole class together, as not every child had the opportunity to answer a question.

These six stories portray a broad picture of the teaching and learning of Shape and Space concepts that were represented by the six teachers and selected for the research.

In the following chapter I will discuss and analyse the similarities and differences that link the stories and discuss the way in which these findings might be interpreted.

CHAPTER 5: ANALYSIS AND INTERPRETATION

In this chapter, I will comment on several themes which emerged from the findings and discuss the implications of these.

5.1 Teacher Education

As a teacher-educator, this issue is of prime importance to me. Two questions come to mind from my reading of the literature, specifically the work of Ball, (2000). She debates the issues of "subject matter and pedagogy in teaching" (Ball, 2000:241).

A. What mathematics or mathematics methodology training did these teachers receive? This question was discussed in the pre-interview.

B. If there is little didactical knowledge, how do teachers go about gaining some insight to prepare for the teaching of Shape and Space concepts? This question was posed in the planning questionnaire which teachers completed prior to teaching the lesson.

5.1.3 Mathematics methodology training

As previously mentioned in Chapter 3, the teachers had a variety of training backgrounds.

Background of teachers

TRAINING	NUMBER OF TEACHERS	TEACHER IDENTITY
Barkley House (after incorporation into Cape Town College of Education, (CTCE), now Cape Technikon)	1	Teacher D

Barley House (before incorporation into CTCE)	3	Teacher B Teacher E Teacher F
UNISA	1	Teacher A
Cape College (Educare)	1	Teacher C

In the pre-interview, all of the teachers spoke about their awareness of lack of mathematical background in their teacher training. They could not remember ever having a subject such as mathematics or mathematics didactics in the curriculum of their teaching course. If any aspects of mathematics were covered in their training, it was number work, and specifically counting.

For example, Teacher C (on mathematics training as part of her course) "No, only Numeracy which was basically the numbers, counting to 9...10 at least and that is it."

This attention to counting as the major focus of numeracy lessons comes through clearly in Teacher D's lesson where she begins by working with shapes, and then moves on to counting the sticks used to make the shapes. She also highlighted the number aspect of her lesson as being particularly successful in the post-lesson interview. This is an area with which she feels comfortable working as it was a memorable part of her training. No teachers mentioned that they could remember learning about ways in which Shape and Space could be taught or of any content knowledge about Geometry. This places them at a serious disadvantage, which has implications for both the types of lessons they will teach, and the methodology they use to teach the lessons. Fennema and Loef Franke (1992:151) found that "the evidence is beginning to accumulate to support the idea that when a teacher has a conceptual understanding of mathematics, it influences classroom instruction in a positive way". Thus, the converse will be true. Teachers who lack content, will have limited conceptual understanding, and their teaching will consequently limit the understanding of their learners.

5.1.2 Mathematical content knowledge

In addition, the teachers showed that they have a limited content knowledge of Geometry.

Teacher A: "I don't remember much of Geometry from college. We did maths up to standard 5 (She means she did maths as far as Standard 5 level as part of her first, primary diploma), so we must have done shapes."

Interviewer: What for you is Geometry?
Teacher F: Size and shape in a mathematical way.

It is apparently evident from the above comments that for the majority of these Grade R teachers, a clear definition of Geometry is lacking. If they are not clear as to what Geometry is, and they do not have a good basic knowledge of Geometry themselves, then it will be very difficult for them to know why Geometry is important so early on in the school curriculum. It will also be problematic when planning a progression of activities to develop children's knowledge of Shape and Space concepts. According to van den Heuvel-Panhuizen and Buys (2005:9), Geometry is in the broadest sense of the word "understanding the space around us. It is related to the two- and three-dimensional world and the related shape and figures." Furthermore, it "offers tools to structure the physical world and to get a grasp on it" (van den Heuvel-Panhuizen and Buys 2005:10),

As can be seen by the teachers' responses, I detected vagueness around their conceptual knowledge of Geometry. Teacher A spoke about concepts of balance as being one of the shape and space concepts she focussed on in her teaching. She also mentioned that when assessing the children about their shape knowledge, she would use a game called "*Brainy Blocks*" (this consists of coloured plastic shapes and picture boards with shape outlines which form a

design. The children must match the correct shapes on to the board to 'copy' a picture).

Interviewer: But how would you take out the shape and space concepts from the Brainy Blocks game?
Teacher A: You see I do my formal assessment and I would actually say to them formally one by one: "What shape is this?" I question the shapes.
Interviewer: How else do you question? You would ask them what it is, and…
Teacher A: Ja, what is it and pick up on sorting two shapes – triangles etc.

The focus on naming the shapes came thorough very clearly here, as with other teachers, and she did not seem to see the need for probing beyond that. Also interesting here, is the use of the word "formally". It is used twice in one sentence. This could be an assumption that when teaching a concept, if you approach it in a 'formal' way, then it has the sanction of being conceptually advanced. In order to give conceptual depth, teachers change the teaching method, not the content.

Teacher C was quite forthright when admitting to her lack of conceptual knowledge.

Interviewer: How would (the children) learn about space using their bodies? Or, what do you expect them to learn about space using their bodies?
Teacher C: I don't know.

As mentioned previously, this teacher was quite honest and open about her lack of mathematical knowledge. She knew clearly what she did not know and was prepared to admit it to the researcher. This teacher would be someone who would be a particularly good candidate for in-service teacher development, because she knows her limitations. Some of the other teachers' conceptual

knowledge was equally lacking, but they were not as aware of it. They were content to continue as they always had.

Teacher D too showed limitations when asked the same question.
Interviewer: What do you expect children to learn about shape and space from their bodies?
Teacher D: I do the listening exercises where I ask them to get a chair, stand on top of the chair, put their foot underneath the chair, so that is where their bodies come in.

This response shows some reference to the use of vocabulary which relates loosely to what Van den Heuvel-Panhuizen and Buys (2005) call "localizing", namely to be able to indicate where something or someone is. However, the first response related to the language concept of listening. Perhaps a teacher who had more knowledge on the topic would have been able to use questioning in a way that would give the children more understanding of the concept of localization. Van den Heuvel-Panhuizen and Buys (2005:147) suggest that becoming familiar with the language of Geometry will help children develop the ability to describe spatial concepts. Sharing their experiences and reflecting on their position in the above activity would have encouraged the learners to communicate mathematically.

Teacher E spoke rather generally when asked about Geometry:

Interviewer: What for you is Geometry?
Teacher E: Hang on a sec, I haven't done maths for years.
I: Anything you can remember from the past?
T: Well, it is to do with angles and things like that and besides pointing out how to fit different triangles together and things like that, one doesn't really deal with angles as such too much I don't think. Well I haven't
I: I want to know what it is for you?

T: Not too much.

I: Don't you want to talk about it?

T: I would really have to think about it. I don't have a negative thing about it; I think maths is good from the logical side and that sort of thing too. For this age group Geometry, as far as I am concerned is working with shapes and things and how they fit together and pointing out different triangles and things like that.

Her understanding of what Grade R children should learn ("working with shapes and things") is broad, and limits the possibility of a teacher being able to make decisions about meaningful teaching based on this loose notion of what Shape and Space concepts 5 -6 year old children should be learning.

5.1.3 Planning an activity

In the light of this apparent lack of knowledge, I wanted to find out exactly what teachers used to assist them in the planning of the content of their lessons. This was important for consideration when planning pre-service teacher education programmes. If I had some idea what teachers were using to plan their lessons, I could refer to this and therefore closer align the lecture situation with what was happening in the classrooms. Therefore, a question was inserted in the questionnaire: What resources did you consider using for this lesson? I had hoped that teachers would indicate where they received their knowledge about what to teach.

A cross reference of resources used with teacher responses in the pre-interview

	QUESTIONNAIRE		**PRE-INTERVIEW**	
Teacher	Resource: practical	Resource: written	Have you read the RNCS?	Response
A	apparatus (detailed)		Yes	Content the same –a bit less
B	Apparatus 3D wooden shapes body		No	Content pretty much what we do
C	Plastic shapes		No	Other teachers say it's the same

D	sticks	RNCS	I've got the file	It says children must work together in a group Spacing and measuring are important
E	Building blocks straws	Childcraft, Exploring mathematics with youngsters	No	I think there is not much change
F	Bean bags rope Large foam shapes	Smile Educators manual	Yes	Better laid out, a bit vague

In response to the question about resources used, 3 teachers (A,B,C) responded by outlining only the practical apparatus that they were going to use during the lesson and three teachers mentioned both practical apparatus and a book reference. Two of these book references were books which would give them ideas for activities, and would not specifically detail the mathematical concepts with which the teachers would be working. Only Teacher D said she used the RNCS as a reference. There are several possible reasons for this.

This teacher has the most recent qualification (4 years out of college) and is the youngest of the teachers in the sample. It is expected that she would be the most up to date with her teacher training. Although she did not use the RNCS during her training, she had some input into OBE during her teacher training. The new curriculum was then in the very early stages of implementation. It is possible that through this awareness, she would have recognised the need for guidance and direction while planning lessons. The older teachers on the other hand, having had no training in OBE, would be more set in their ways and possibly felt more comfortable using tried and tested teaching resources.

Perhaps Teacher D, having recently come out of a Higher Education Institution (the one where I currently train teachers), has learned to "play the game". She knows full well that she would have been expected to consult the RNCS as part of her lesson preparation, and therefore wrote this down as I (a teacher trainer and researcher) would have expected it.

I expected that more teachers would refer to the RNCS as a resource for their lesson, especially in the light of the fact that during the pre-interview, I had mentioned this document to them and inquired about their engagement with it. Two teachers said they had read it. Most (4) teachers were unfamiliar with the RNCS, but passed judgement on its contents based on hearsay. (See above table) The 'teacher network' is well known for spreading rumours and sometimes creating an unrealistic panic, especially when changes are imminent. In this case, teachers used their peers to reassure themselves that few changes to their planning and teaching were necessary, and that they were in fact conforming to RNCS and OBE requirements.

This is an interesting phenomenon. Jansen (1999a:147) cites several reasons why OBE will fail. One of these is the complex language used in Education Department documents. He admits that he himself still finds "the maze of jargon and tortured definitions intimidating". These are the words of a highly educated academic. It is little wonder therefore that teachers do not fell comfortable consulting these documents as the language is likely to be even more inaccessible to them.

Teacher B went so far as to say:"We don't have a specific curriculum."
I do not believe this to be true. There is for the first time, a very clear Curriculum for Grade R with regards to the teaching of Shape and Space concepts (Learning Outcome 3). However, the assessment standards are very broad and general and do not shed much light on exactly how to achieve these stated goals. Given the fact that the teachers received little mathematical input during their teacher training, it would not be easy for them to plan and design activities to achieve these assessment standards. Teacher B relied on other teachers to reassure her that the new curriculum content was similar that which she was accustomed to using.

Jansen (1999b) reports on a study in thirty-two Grade 1 classrooms, in the early days of the implementation of OBE. He found that teachers had "vastly different understandings of OBE, even within the same school". (Jansen, 1999b:206) This was apparent in the six teachers observed in this study too.

I consider the teachers' habit of relying on their previous experience when planning and preparing lessons to be a genuine reflection of what occurs every day. Jansen (1999b:209) found that "teachers generally claimed that there were some things that they were doing differently since the introduction of OBE, but that they were mainly teaching as they did before OBE". The Grade 1 teachers in his study relied on the same content that they had previously taught in their lessons.

Five out of the six teachers did not use the RNCS to plan and prepare their lesson. Teachers A, B and C did not use any written reference to plan and prepare their lesson. Teachers have limited content knowledge around this topic. By their own admission, they are not confident mathematicians, and it would therefore be expected that these teachers would need to consult books to assist them to teach mathematically sound lessons. These teachers were being visited by somebody from outside. Surely they would want to appear to be more knowledgeable about the topic? The teachers are relying on their innate feel for the needs of the children, rather than consulting appropriate resources. If they had consulted more 'learned' documents, they could have made themselves appear to be more prepared. Five out of six of the teachers had not felt pressurised by a visiting researcher to deviate from the norm and write down something that seemed untrue; i.e. "I have consulted the RNCS in preparation for this lesson".

This shows that the integrity of the teachers is to be commended. Perhaps one could say that they are over-confident in their ability to teach without the need for extra input from WCED documents or other resources. However, this is not

sufficient to ensure that they are in fact using the age appropriate methodology and using the required content.

In retrospect, the question about resources could have been worded more clearly, as it seems they understood the word 'resource' as meaning practical apparatus, which is understandable as in pre-service training, in their lesson planning, students are asked to list all the apparatus they will use under a heading - "resources". Therefore a misunderstanding could have taken place.

It is imperative that teachers become familiar with the *full* content of the RNCS document so that they are able to teach Shape and Space concepts in an age appropriate and mathematically sound manner. However, it is at this point that we should consider whose responsibility it is to ensure this. Rasool (1999:179), in response to Jansen's criticisms of why OBE will fail, sums up his argument by saying: "...the question is not whether OBE should be implemented, but rather whether sufficient support and encouragement is being given to teachers by all interest groups in education". Teachers will need sympathetic guidance and clarification of the content of the RNCS from the WCED if they are to engage with these complex documents. It is only when this happens that the content will be understood by teachers, and only then will there be the possibility of their using it as part of their daily lesson planning.

5.2 Outcomes Based education

The advent of OBE requires teachers to shift their previous perceptions of teaching and move towards an investigative approach to the teaching of Mathematics. One of the aims of this research was to gain insight extent to approaches used by the Grade R teachers. How have Reception year teacher changed their previous teaching and preparation methods to accommodate the needs of an outcomes-based approach?

Teacher E:
"A lot of what they are saying you must do must be practical, and Grade R is practical, so I don't find there is much change in it."

At first glance it is easy for such a misunderstanding to take place. Looking at the introduction to the learning outcomes in the RNCS document we read: "The study of space and shape in the Foundation Phase is very practical and hands-on." Some teachers naturally assume that all their teaching is "hands-on"; therefore they are already conforming to RNCS and OBE requirements in their daily activities. They do not see the need for change and therefore continue confidently in the ways in which they feel most comfortable.

It is clear from the data that teachers teach with their 'gut'. They have an over-confidence which precludes them form consulting documents or accepting new ideas. This is both a positive and a negative feature. It is helpful, because the teachers feel confident about their work and teach empathetically in the best interests of the child. They do need to know the children well in order for optimal teaching and learning to take place. It is harmful, because the teachers are staying in their 'comfort-zone' and do not deem it necessary to move out of this at all. This was clear from the comments of Teacher D:

Interviewer: What are your thoughts on OBE and the new curriculum?
Teacher D: I was used to the swing of OBE, so when the new documents came, it was just a new thing and I'm just going to continue with what I'm busy doing in my classroom... It was just: "The Department's doing something new again. Over a couple of months it's going to be something else again." So I didn't really get all excited.
Interviewer: It doesn't bother you particularly?
Teacher D: As long as I do my work... As long as I learn and I do my own research and I go through the books and I'm not waiting on JL (name of

departmental official) or anybody else to give me the notes and tell me what I'm supposed to do and the area I'm supposed to cover.

The cynicism with which this teacher considers the new curriculum is quite perturbing, yet not surprising. She has clearly given up on any support from the WCED and prefers to continue with her usual mode of teaching. Jansen (1999b:208) found that "the common thread in teacher responses was for a different quality and frequency of teacher preparation for OBE".

The overwhelming majority of teachers (5 out of 6 teachers) stated in the pre-interview that children best learn Shape and Space concepts through their bodies. The 6th teacher used the words "hands on experience" which could be said to be a similar idea. However, when the activities were presented, only 2 teachers used that principle in their actual lesson. It could be assumed that somewhere in their training, these teachers were told that this was an essential way through which children learn. One only has to look at Piaget's sensorimotor stage of development, to realize that from birth, children are experiencing the world and its effect on us through the medium of their own bodies. Freudenthal (1991:76) while stressing the importance of using practical materials in the teaching of Geometry states that: "the best palpable material that you can give the child is his own body." It seems as if teachers are unable to use these principles that they know and believe in, from the child's earliest learning, and adapt it for their pre-school learners.

So teachers do not consult the RNCS or any official documents which could help them and give them some guidance as to what to teach. 3 out of the 6 teachers consulted no books, and only one out of the 6 used the RNCS. Teachers DO however talk amongst each other as mentioned previously. They mentioned hearing from their colleagues that the new OBE requirements were generally the same as what they had done before. Teachers are evidently aware of the fact that there are limitations in what they are teaching. It is possible that the cascade

model used in the introduction of OBE could be responsible for this. Teachers seek answers, not from documents or books, but from their peers. Teachers do not seem to have discussions around curriculum content requirements, rather around ideas for activities from students and colleagues.

Teacher C spoke both about

a) Obtaining new ideas for activities, and
b) discussing issues of curriculum.

a) Obtaining new ideas for activities

"Sometimes the students come to the class... they come with ideas and then I think good show, I can steal that idea."

This is a convenient resource. Depending on the worth of the activity, it could be a very useful means of gaining some expertise. Teachers have the children's best interests at heart. They want to make lessons interesting and 'fun' for the children. New ideas can keep a teacher inspired and motivated. But they do not necessarily know why they are using a particular idea, or even what concept the activity is meant to teach or reinforce. There is no rationale behind the use of the activity. The use of the RNCS would help them to link "good ideas" with mathematical concepts.

b) issues of curriculum

"I tell her (the grade 1 teacher) I have done this and I have done that, is it okay and is that everything they are supposed to know."

This teacher was the most honest about her lack of knowledge. To be sure, she is the least qualified, and by her own admission wants to upgrade her qualification. She needs reassurance. She wants to know that what she is teaching is correct. This is a positive way of using your colleagues as a sounding board. Colleagues can be a very useful resource, depending on their experience

and knowledge. I think that other teachers do this too, but they just do not talk about it.

It is clear that these teachers discuss new WCED requirements amongst each other, especially in light of the fact that extra time for training is expected from the teachers. As the RNCS document was very new at the time of the data collection, it is not unexpected that so few teachers had read it.

Three teachers mentioned other teachers as a useful resource for ideas, especially when asked how they would extend children's knowledge. These same teachers mentioned how well they knew the children. Teacher A said, "If you just tell me the name of a child, I can tell you exactly where they are at." I think they are relying on their innate understanding of the children's capabilities to decide on what content needs to be taught.

5.3 Curriculum demands

As stated in the introduction to the learning outcomes in the RNCS (2002:10), the Foundation Phase focus for the study of Shape and Space, (LO3) states that: "Learners should handle objects and shapes, cut out and draw sketches, and describe them with appropriate and expanding vocabulary". This is further expanded in the document with six assessment standards for Grade R.

Teacher D added the following comments to her planning questionnaire: "There's lots more to learn about Shape and Space". This is an extremely telling statement. It is possible, that having briefly read the RNCS, (this teacher mentioned that she "had the file"), she realised that there was more content than expected, but she was at a loss as to a conceptual understanding of that content, and how to convey it in age-appropriate activities to her learners. This teacher could not rectify misconceptions (see diagram on pg 64). When she asked the children to build a rectangle using sticks, they built some unexpected shapes.

She did not know how to help them and simply resorted to the aspects of mathematics that she felt comfortable teaching, namely counting. She asked the children to count the number of sticks used and then proceeded with the following activity. Ball (2005:21) states that "students who learn shapes only by illustration and example often construct images that are entirely wrong". She refers here to the typical definition by teachers of a rectangle; namely that it is "a shape with two long sides and two short sides and right angles". She continues by saying that "teachers need skill with mathematical terms and discourse that enable careful mathematical work by students and that do not spawn misconceptions or errors".

Two teachers mentioned that it was not possible for pre-school children to learn through the abstract. This bears asking the question. Once children have had a variety of practical, concrete experiences, at which point do they transfer this into what Piaget calls abstract logico-mathematical knowledge? Will their knowledge of Shape and Space concepts be limited to:

1. The recognition of shape names,
2. The number of sides of the four basic shapes,
3. The recognition of shapes in the environment, (a book looks like a rectangle)
4. The putting together of shapes to make pictures? (A square with a triangle on top becomes a house)

I will now examine the lessons taught more closely, to ascertain how the teachers are meeting these curriculum demands. Several issues have arisen in the data, which will be used to categorise the teaching.

- selected content, repetition of topics and media
- the use of vocabulary
- looking for shapes in the environment, and
- the use of collage.

An overview of lessons observed

TEACHER	TOPIC OF LESSON OBSERVED
A	Revision of shape names. (Circle, square, rectangle, triangle) Teacher puts two shapes together and children suggest what it could be. Collage: make a picture by putting shapes together. Children are encouraged to cut shapes where necessary
B	Question relating to what a flat shape could be (reminds them of: e.g. triangle – roof) Making shapes using sticks, to determine the number of sides Paper folding – making a hat. Baking – making hot cross
C	Children given clues and must give the correct shape name. Looking for specific shape names in the classroom environment. Using more than one child to make shapes with their bodies. Tracing around the perimeter of the body with crayons.
D	Shape building with sticks. Recognition of objects in shapes: What does this shape remind you of? Number of sides of the various shapes. Counting.
E	Recognition of shape in a poster, name and object represented Triangular shapes and their properties.
F	Introduction using revision of shape names and colours. Making shapes with ropes. What various shapes remind you of? (e.g. oval – rugby ball) Seeing shapes in musical instruments: Tambourine – circle, Chime bar – rectangle, Triangle – triangle, Maracas - oval

5.3.1 Selection of topic

When analysing the teacher's chosen subject matter, it is interesting to note that 5 out of 6 teachers chose to begin the lesson with the revision of basic shape names. (Mostly circle, square, rectangle, triangle) Simple clues or an example were given, and the children responded, mostly in unison. The shapes used were

always the same size, colour and in the same orientation. Learning Outcome 3 states:

"The learner will be able to describe and represent characteristics and relationships between two-dimensional shapes and three-dimensional objects in a variety of orientations and positions."

Furthermore, in the assessment standards for Grade R, the learner should: "describe, sort and compare three-dimensional objects..." There is no mention made in the RNCS of two-dimensional shapes, yet all these lessons were about two-dimensional shapes.

The concept of perceptual constancy (or constancy of shape) was never explored. Perceptual constancy, according to Del Grande (1990:15) is a term first used by Piaget and Inhelder. "It involves the recognition of certain geometric figures presented in a variety of sizes, shadings, textures and positions in space, and their discrimination from similar geometric figures". If the shapes had been of different sizes, colours or rotated from the way in which the children usually experienced them, the activity would have been some challenge to the children in the recognition of the shape. These children are 5 turning 6 years old, and could probably recognise these simple shapes from the age of 3 or 4. However they have possibly not yet developed the ability to conserve shape. (The principle of conservation of shape implies that a shape remains the same despite its appearance) The children are not being extended to understand the constancy of the shape's properties. They are required to memorize the name of the shape and a simple definition of its properties, and recite this back to the teacher. This goes against the principles of OBE, which allows for a "learner-centred and activity-based approach to education.(Department of Education, 2002:1) At this stage, children's ideas about shape should be developed through experiential hands-on activities, where children can make meaning of mathematical concepts through the use of appropriate apparatus. Van den Heuvel-Panhuizen and Buys

(2005:145) define understanding geometry to be "*grasping* the physical world". They propose that the goal of geometry in primary school should be "developing the children's abilities of spatial visualization and reasoning" (van den Heuvel-Panhuizen and Buys, 2005:145)

Little evidence was found in the data of opportunities for the children to reason and make sense of concepts for themselves. It is important to examine the use of mathematical language at this point, as it is through communication that children will make meaning.

5.3.2 Use of Vocabulary

The RNCS also calls for appropriate and expanding vocabulary. The kind of mathematical language which promotes understanding according to Hiebert et al (1997) is one where the teacher guides and scaffolds discovery (of concepts of the properties of shape in this case) through the use of appropriate language and questioning. In the classrooms visited during this study, there was little opportunity for children to use language in a reflective way. According to Anghileri (1995:7), it is essential for children to "use language and negotiate meanings that enable them to make sense of the words and symbols required for abstract mathematical thinking".

If asking questions and waiting for a chorus response is a form of assessment, which many teachers regarded as inherent in their teaching, then it is a rather ineffective task, as the children who know the answers, respond with the loudest voices, so those who are unsure as to the shape names, remain unknown to the teacher. At the end of the task, the teacher would have received sufficient positive responses to the questions to reassure herself that the children know the shape names.

Teacher A maintained that repetition was the way in which she ensured that children were able to grasp a concept:

Interviewer (when asking about slower learners): What happens when C gets to Grade 1 and he doesn't know what a circle is?
Teacher A: No, by then he would have because I would go on and on about circles until I see that C gets a circle.

This was evident in her lesson when she held up two painted wooden circles and asked:

Teacher A: What is it?
Children: A circle.
Teacher A: What colour is it?
Children: Yellow.
Teacher A: Draw one in the air.
All 25 children do this together.
Teacher A: What is it?
Children: A circle.

Teacher C also used chorus responses repeatedly during her lesson, interspersing the answers with "Why" when wanting some elaboration.

These tasks seem below the children's level of thinking and did not demand much from them on a cognitive or process level. Pimm (1991:22) maintains that "teachers cannot make pupils learn – at best, they can provide well-thought out situations which provide opportunities for pupils to engage with mathematical ideas and language".

5.3.3 Shapes in the environment

All the teachers used the principle of finding shapes in the environment in various ways. Sometimes, two shapes were put together and children had to suggest what it could be (a triangle with a circle on top could be an ice cream). In other cases, a shape such as a triangle was held up and the children were asked what it reminded them of (a triangle could be a roof or a hat). The simplest form of this exercise entailed a shape being held up, and the children had to look around the classroom and find an object of that shape, (for example a rectangle was the door).

These shape activities are simple, yet *derive* from one of the assessment standards (AS) for Grade R, namely AS 1:

"The learner recognises, identifies and names *three-dimensional objects* in the classroom and in pictures." (Department of Education, 2002:16).

However, the activity requires the use of three dimensional objects rather than two-dimensional shapes. Children are omitting the early stage of working with three-dimensional objects. In addition, children are not being given opportunities to operate with the two-dimensional shapes. Van den Heuvel-Panhuizen and Buys (2005:196) describe the term *operating* to mean "doing something with a shape or figure". The state that "by operating with shapes and fgures, children learn to recognise them and discover their properties".

It could be argued that a shape recognition activity could relate to what Hiebert and Lefevre (1993) call procedural knowledge. They propose that there are two forms of mathematical knowledge, namely procedural and conceptual. Procedural knowledge relates to:

- "formal language or a representation system, and

- rules algorithms or procedures used to solve mathematical tasks".

(Hiebert and Lefevre, 1993:6)

Conceptual knowledge, on the other hand, is "a web of knowledge, achieved by the construction of relationships between pieces of information." (Hiebert and Lefevre, 1993:4)

Linking the shape names to objects in the environment, can be seen as an attempt to connect conceptual and procedural knowledge. Hiebert and Lefevre (1993) state the case for the development of these two forms of knowledge alongside each other. In 5 out of 6 of the presented activities, teachers asked the children to relate the shape to an object in the environment, eg: in the case of teacher B: "I am thinking of a shape, it is the same as the carpet we are sitting on"

There is a big discrepancy in the answers given during the pre-interview at the beginning, when asking about the children, and later when asking questions about curriculum and pedagogy and during the lesson observed. Teachers know their children well, and enjoy talking about their abilities, difficulties, and anecdotal incidents. When moving, in a reflective mode, to asking about the curriculum, mathematics, and Geometry in particular, there is a marked difference in the length of the teachers' answers. They are much shorter, little elaboration given. This could be an indication of insecurity and lack of confidence in their mathematical knowledge and knowledge of the curriculum. There is also a marked difference in their responses to how children learn, and their ability to use that knowledge in the methodology of their lessons. It is possible that during their training, teachers were taught certain "rules" for best practice, such as learning through play, and allowing children to develop at their own pace, but there are some severe misconceptions here.

In this research, teachers seem to have misunderstood the principle of allowing children to work at their own pace. Many teachers interpret this as leaving children to their own devices when they can correctly answer a question. I consider this to be problematic, as these children never have their knowledge base expanded by the teacher. The teachers observed in this research seem to breathe a sigh of relief when the child answers correctly, and little teacher intervention is required or given from that point onwards. The child who cannot answer correctly, on the other hand, is allowed to (in the words of the teachers in this survey) 'develop at their own pace'. This seems to mean repetition of the concept (to the whole class, even those who already know) and a patient waiting for the 'penny to drop'. In allowing this time for the concept to be understood, few alternative strategies are employed to assist the child. Teachers do not look at ways of altering their teaching methods so that they can help the child. The phrase "develop at their own pace' seems to have given teachers the permission to wait until the learning has taken place.

5.4 Extending competent learners.

This is an area in the study which fascinated me. It also links to the points mentioned earlier, namely, the teachers' perceptions of OBE and the demands of the curriculum. The Grade R curriculum has been extended to include more formal work in the teaching of numeracy. It is the first time that there has been such a clearly stipulated 'syllabus' for mathematics teaching. As stated in the introduction to the study, Grade R is now included in the GET band of education, the first 10 years of compulsory schooling. Previously, the Reception year was part of pre-primary education, using an informal approach and always kept very separate from Grades 1 – 12, the accepted years of formal schooling. Since the advent of OBE, it is the first time that maths has been fore fronted in the reception year as a learning area which needs to be taught discretely. It must still be taught in an age-appropriate way, which is using the principle of integration, so that the mathematics can make sense to children. (Teachers sometimes

confuse the principle of integration with a lack of planning. Although Incidental learning is advocated, clear planning and goal-directedness is required.)

Children in the Reception year are now 5 turning 6 years old, a year older than previously, when most of these teachers trained. . Knowing the names of the basic shapes and a simple definition of their properties is a goal most teachers aspire to. However, many children have come to school with this knowledge, as was not the case for younger learners. The teachers do not seem to have the resources to extend the children beyond what they already know. I particularly probed this in the pre-interview, and the teachers said that they would give the children activities in workbooks, and teach them more advanced shape names, such as hexagon and diamond. According to Clements (2000:83), "children begin forming concepts of shape long before they enter school...and very young children can learn to name and sort shapes accurately and describe their parts and attributes". In the light of this, it seems that teachers do not what age-appropriate activities to use to extend the thinking and conceptual development of the Grade R learners.

It is my conclusion that the state of teaching and learning of Shape and Space concepts in the sample schools happens at a very basic level, and does not differ that greatly from school to school. Practical experiences are important to all these Grade R educators and integrating these activities with their weekly "theme' is of paramount importance. Teachers ask low-level questions and rely on chorus responses to reassure themselves that they are competent mediators of learning. The teachers observed did not seem knowledgeable about the topic of Shape and Space, yet felt confident that they were teaching using an Outcomes-Based approach. They did not use resources as part of their planning, and were reluctant to consult the prescribed documentation. (RNCS) Teacher networking is common, but this is sometimes dangerous as it simply a means of console themselves with the fact that they are "doing the right thing". Teachers

want help in this area of mathematics teaching, but find reading documents from the WCED unnecessary.

In the following chapter, some recommendations are made which could outline the way forward for improving the teaching and learning of Shape and Space concepts in the Reception Year.

CHAPTER 6: CONCLUSION

In this final chapter, the threads of the study are drawn together and suggestions are made for the future of teacher development. Drawing on the information received from this study, proposals are put forward for future research of this nature.

6.1 Limitations of the study

Limitations of the case-study approach need to be taken into account. A small study of this nature does not allow possibility for generalisability of results *and is predominantly of an inductive nature.* All findings will have to be seen in the light of the fact that only a limited sample was studied. Rose (1991) argues that this can be seen as both a negative and a positive feature of the case-study approach. Generalisability has come to mean "the ability to extrapolate with statistical confidence from a sample to the population from which it was drawn."(Rose, 1991) However, I attempted to include a diverse range of learning sites, teachers, and learners as explained previously. Rose continues that survey samples are often limited to localised communities rather than national populations, so a degree of generalisability is possible since a range of sites and samples have been selected within a localised community.

The sample of this study was further limited by language restrictions as only English medium instruction was used. The researcher is English speaking and as the use of language by both the teacher and the learners is crucial to the discussion of the topic, use of English will allow for maximum clarity of interpretation. No Afrikaans or Xhosa speaking sites will be used. These two language groups are highly represented in the Western Cape and could produce substantial variation in the findings. The teachers on these sites could have attended vastly different teacher education institutions, therefore implications for pedagogical content knowledge and methodology exist. However, the cost

implications of employing a translator and transcriber were prohibitive as this research was largely unfunded.

It must be re-iterated that, once in the classroom environment, there were certain factors which could have influenced the validity of this study. One of these is the classroom environment. A teacher is judged by the state of her classroom. All classrooms had children's work on the walls, but some were simple photocopies, which each child had 'decorated' or 'coloured in', thus giving the impression that creativity was lacking and the teacher did not allow for individual differences.

During qualitative research and especially with the use of interviews and observations of an open-ended nature, there is an element of unpredictability which will occur. As far as possible, the framework of the research, was adhered to through semi-structured observations and interviews, but unexpected issues cannot be excluded from the findings. This is one of the strengths of the case-study approach.

The pre-suppositions of the researcher, regarding her experience of Reception year teachers' mathematical knowledge, and subject-didactical expertise, could lead to bias. Reception Year teachers have in several instances mentioned to the researcher their lack of mathematical knowledge. There is therefore an existing hypothesis on the part of the researcher, that lack of mathematical content knowledge on the part of the reception year practitioner impacts on the depth of mathematical knowledge elicited from the learners. Viadero (1998) states the following:

"Young men, planning to become teachers, for example, were the least likely of all the career groups studied to score at high levels of proficiency in math."

This implies that teachers who have a poor mathematical content knowledge and could therefore experience limitations when designing mathematical tasks which would lead to understanding.

Validity of the reliability of the information and data collected during research is integral to the integrity of any study. Since all data collected within the qualitative paradigm is subjective, and this includes the interpretations made by the researcher, it becomes important to provide mechanisms for validation which are congruent with this subjective methodology. According to Hitchcock:

> "(f)or the qualitative researcher, validity must be concerned with the degree to which findings capture the reality of the situation under investigation. We are dealing with people's constructions of the world and the researcher is trying to capture this, so what seems to be true for the subjects may be more important than what is true in the researcher's frame of reference."
>
> Hitchcock and Hughes (1995:324)

This methodology was selected to attempt to capture the reality of the teaching and learning of Shape and Space concepts in the Reception Year. Through the use of interview, a questionnaire and a lesson observation, I hoped to create a picture of some of the understandings of these teachers and how they translate these into meaningful learning experiences for their learners

6.2 Teaching Approaches

It is clear from this study that there are certain consistencies of approach to teaching of Shape and Space in the Reception Year. Initially, questions were asked in this study as to how teachers made decisions about what to teach the Grade R learners. Most teachers seemed to rely on a "gut feel' as to what

children needed to learn. With low levels of mathematical content knowledge, it is hardly surprising that low level content was taught, much of which the children were already familiar with. The majority of the teachers were relying on their school-acquired knowledge of mathematics, last encountered many years prior to this. Along with Philippou and Christou (1997), Fennema and Loef Franke (1992:156), refer to the pre-conceived "theories and belief systems, which influence teachers perceptions, actions and plans in the classrooms." Four out of the six teachers in this study were trained at the former Barkley House Teachers' College, which promoted a "holistic and integrated, developmentally appropriate, free and creative teaching approach" (Rushby, 2004). Seemingly, this influenced the choice of subject matter, as many teachers referred to the way in which they made a choice for the lesson taught by ensuring that it fitted in with the theme that they were currently presenting in their classes.

It is true that mathematics taught in context is going to be more accessible to children, and is more likely to promote understanding. Integrating the curriculum is an age appropriate strategy used in the early years, (van den Heuvel Panhuizen and Buys, 2004, Schickedanz et al, 1983). However, Hiebert et al (1997:26) are emphatic that "tasks should be selected for the mathematics of the situation, rather than the extraneous features and that as one... looks back, the mathematics of the situation should be the most salient residue". It seems that teachers struggle with the ability to make the mathematical concepts the starting point, and often integrate for the sake of integration, because they are aware that this is good, age-appropriate practice.

It is possible that a series of mathematics workshops which outline to the teachers the mathematical reason for presenting certain activities, could be beneficial here. During the study, teachers were anxious to find out whether this would be an outcome of the research and were keen to "get new ideas.' I maintain that the ideas are essential for teachers, but only if combined with mathematical input which would clearly outline the concept being taught, and

what this concept would assist with later in the school curriculum. Teachers would therefore be able to assist in the "constructing of mathematical concepts." (Geist, 2001:13).

Graven, (2002:8) refers to the "radical teacher change" expected by the new curriculum, and highlights how ineffective this has proved to be, as contrasts it to a "life-long" learning process, where a gradual immersion in a new way of thinking can help teachers to develop a different way of looking at, and later amending their practice. Graven (2002) states that in the in-service PLESME project, she started out with an unclear understanding of what "best practice" should be. In this study, I too had a very vague notion of what this constituted. On reflection, it is clear that "best practice" must definitely include the content of the RNCS, combined with developmentally appropriate practice. However, it seems that the teachers' notion of what is age-appropriate for a Grade R child is simply not challenging the majority of these learners.

There are countless resources for the teaching of Shape and Space concepts available to teachers. The subjects of this study did not even see fit to consult some of these, let alone conduct a process of "appraisal, selection and modification" (Ball 2000:244). Is this caused by a belief that they 'know it all' already? I think not. It could be said that the insecurity of the teachers caused them to rely on previous tried and tested activities with which they feel secure. Ball, (2000:243) states that it is possible that teachers "may not be able to size up their textbooks and adapt them effectively". I think this inability could be the very reason that the teachers in this study did not consult many resources in the planning of their lessons.

The role of the Reception Year teachers needs to be redefined in terms of their participation in the Primary School. Traditionally, they have been separate, both physically and academically, from the rest of the school. Their classrooms are far away from the rest of the Foundation Phase, few curriculum issues are discussed

with the rest of the FP teachers, and no-one is too sure what they do on a daily basis. They play (so therefore their classrooms are noisy, as compared with the rest of the school), their activities are messy – another reason for them to be kept far away and their daily programme does not include bells and periods, as does that of the rest of the school.

All this must change. In order for a meaningful Shape and Space mathematics programme to be taught, regular discussion is necessary with the rest of the Foundation Phase teachers.

It is clear that teachers are not in the habit of consulting resources when designing activities for their grade R learners. The Freudenthal Instiitute trajectory, van den Heuvel-Panhuizen and Buys (2004), offers many practical suggestions for purposeful teaching of Geometry concepts in the early grades. This could be included in pre-service teachers' text book list so that they are used to consulting it for lessons.

Many teachers expressed the need for workshops in this strand of mathematics, as they verbalized their insecurities about teaching the subject. The above book blends methodology and content in a reader-friendly manner. This could be used as a basis for the workshops.

We are a society that needs to be nurtured (Bloch 2005). Our teachers are being evaluated constantly. They are assessed formally by Education Department officials, by each other as part of the quality assurance system, and informally by the students and lecturers who visit their classrooms. This is hardly a nurturing situation. I know from the responses of the teachers, that a visit from a researcher was a stressful situation. There is something about the teaching and learning of mathematics that creates fear. If a teacher (or a learner) is afraid, how does she teach (or learn)? How does she effectively select resources and activities for her children? Fear will affect not only these choices, but also the

methodology used to convey content to learners. I am therefore left with the question: Instead of these constant evaluations used to improve teaching and learning, how can we nurture our Grade R teachers (and through them their learners), into enjoying the teaching of Numeracy, specifically, Geometry? This question must be addressed with the utmost sensitivity.

It is clear that the teachers interviewed did not have sufficient content knowledge in Geometry, to allow them to extend the thinking of their learners. These same teachers do, however, have the potential to acquire that knowledge. It is now the role of the Education Department to firstly believe that this is possible, and then to set about devising ways in which teachers can become empowered to in turn empower their learners with Geometry activities that are challenging and meaningful.

The assessment standards need to be fully understood by the teachers. They should continue to 'unpack' each assessment standard as illustrated on page 31 of this document to determine the range of content contained therein, what the mathematical significance of each assessment standard is and how to present it in a developmentally appropriate way, the teaching of the educators would be enriched by this pedagogical content knowledge. This task needs to be undertaken, with sympathetic assistance, by the advisors of the Western Cape Education Department. "Teachers need to feel confident that the framework for good teaching lies within themselves and their own particular context" (Breen, 1999:120).

I have become aware of the fact that it is a complex undertaking to 'empower the learners'. In order to do this, an educator must enter into the learners' space, see where they are at, what they know, and proceed from there to create meaningful situations for learning. It is apparent that the teachers struggle to do this. Analogous with this is my own struggle. As a researcher, I also had difficulty entering into the teachers' space with empathy and understanding, in order to

fully grasp where they are at, what they know, and finally proceed from there to create meaningful situations for learning in pre-service teacher education.

I am aware that a glib list of recommendations could be problematic. Breen (1999:117) reminds us that "the passing on of methodology does not happen by osmosis". A handful of workshops is hardly going to create a sweeping transformation. After all, teachers are fed up with change, they have had one workshop too many. As Breen (1999:118) says, "there will also have to be fundamental shifts in their belief systems that will have serious repercussions in their own lives".

I only have to look back on the past few years of completing this research to see what the implications of this can be. Changing my own practice as a teacher educator was one of the aims of this study. It has not been an easy task. When I began the classroom observations, I was a very different kind of teacher-educator from what I am now. Initially, I used to approach my lectures with a very clear picture of how numeracy had to be taught to the Foundation Phase child. After all, I had years of tried and tested experience, and had 'proved' that this was the correct approach to use. Now, after having had the privilege of visiting these six teachers, I recognise that I was basing these approaches solely on my own practice. After the classroom visits, I had to allow my subjectivity and critical 'voice' to be put aside, and allow the facts to speak for themselves. Teachers are different, each one brings something unique to the classroom, and they have taught me to look for that individuality and respect it. I was in danger of turning my students into clones and denying them the opportunity to follow their own path of reflection to become sound numeracy teachers.

I have had to look long and hard at the authoritarian way in which I approached this subject in the early stages. I have realised that there is not one way, but many, that things are not always what they seem, and that teaching mathematics is not a simple or straightforward undertaking.

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APPENDIX A

Navrae Enquiries IMibuzo: Dr Ronald Cornelissen
Telefoon Telephone IFoni: (021) 467-2286
Faks Fax IFeksi: (021) 425-7445
Verwysing Reference ISalathiso: 200300404- 0024

Wes-Kaap Onderwysdepartement
Western Cape Education Department
ISebe leMfundo leNtshona Koloni

Ms A. P. Lombard
Bruntsfield
3 Gordons Road
KENILWORTH
7708

RESEARCH PROPOSAL: AN INVESTIGATION INTO THE TEACHING AND LEARNING OF SHAPE AND SPACE CONCEPTS IN A SAMPLE OF RECEPTION YEAR CLASSROOMS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **8th April to 30th April 2003**
6. Should you wish to extend the period of your survey at the school(s), please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
7. A photocopy of this letter is submitted to the principal of the school where the intended research is to be conducted.
8. Your research will be limited to the following Schools: **Westcott Primary, Monterey Pr-primary, Bergvliet Primary, Heathfield Primary, Yesgua Christian School and Sweet Valley Primary.**
9. A brief summary of the content, findings and recommendations is provided to the Director: Education Research.
10. The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Education Research
Western Cape Education Department
Private Bag 9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards.

Signed by candidate
Signature Removed
HEAD: EDUCATION
DATE: 2003-04-07

APPENDIX B

PRE-INTERVIEW

1. How do you think children best learn about Shape and Space?
   What are your theories about how children learn Shape and Space?

2. What do you expect children to learn about Shape and Space from their own bodies?

   How do you mediate this?

3. What do you expect children to learn about Shape and Space from construction activities?

   How do you mediate this?

4. Curriculum 2005 is being debated extensively at the moment. What are your thoughts about it? How do you interpret what it says about the teaching of mathematics/ of Shape and Space?

5. How important should Shape and Space be in the R year curriculum?

6. Why do you think that Shape and Space is in the R year curriculum?

7. What for you is Geometry?

8. What Shape and Space concepts must you directly teach to the children?

9. What spatial concepts must children make sense of for themselves?

10. Do you have any other comments to make about how children learn spatial concepts?

APPENDIX C: QUESTIONNAIRE

Please present an activity where shape and space is involved somwhere: about 20 minutes.

QUESTIONNAIRE ABOUT ACTIVITY PRESENTED
Please complete this as part of the lesson presented.
(I will collect this when I come to visit your class.)

*DATE OF VISIT:*_____

1. When faced with presenting this activity, how did you decide which particular aspect of shape you were going to deal with?

2. What have you taught the children about shape before you presented this activity?

3. What resources did you consider using for this lesson?

4. Outline how you came to a decision about the resources you used?

5. What are the important concepts and/or words which you will highlight/want the children to use, during this lesson?

6. Briefly outline the shape activities which you will continue with after this particular lesson?

7. Are there any other comments you would like to make about the planning of this lesson?

Thank you for completing this questionnaire.

Ana Paula Lombard

APPENDIX D

POST INTERVIEW: POSSIBLE QUESTIONS

1. Is there any aspect of the lesson that you consider to be a highlight?
2. What happened during the activity that was a good exapmle of how Shape and Space *should* be taught?
3. Is there an example that happened during the activity that is an example of how Shape and Space should *not* be taught?
4. What for you was the most difficult part of the lesson?
5. Is there any aspect of the activity that you are particularly pleased with?
6. Is there any aspect of the lesson that you are not pleased with?
7. Any other comments about Shape and Space which you would like to make?