GRAPHICACY AS A FORM OF COMMUNICATION IN THE PRIMARY SCHOOL

HALF-THESIS

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ABSTRACT

Children of today inhabit a multi-dimensional world, and in order to communicate effectively in it, they need the ability to utilise four forms of communication namely, oracy, literacy, numeracy and graphicacy. Communicating in graphic form requires an ability to both encode and decode spatial information using symbols, which requires the utilisation and application of spatial perceptual skills and concepts. The acquisition of graphic skills has been influenced by traditional developmental perspectives; increasingly the assumptions underpinning these have been challenged by more recent international research findings.

The draft Curriculum Framework for General and Further Education and Training (1996: 18) identifies graphic literacy as one of the critical outcomes of the new South African curriculum. For graphic literacy to be an achievable outcome of the new curriculum, we need to investigate the skills and concepts underpinning this form of communication.

The goal of this research is to investigate graphicacy as a form of communication in South African primary schools. However, given the scope of a research project of this nature, it was decided that rather than dealing with graphicacy *per se,* pictures as the most frequent and concrete type of graphic communication encountered by young learners would be focused on. In seeking to investigate pictures, the first stage of the study is concerned with diagnosing and illuminating children's graphic skill development through identifying: what skills they use; how they use and apply these when communicating through and interpreting symbols; and the difficulties they experience when, firstly, encoding spatial information through a series of practical and drawing tasks; and secondly, when reading and interpreting pictures. The second stage of the study investigates the extent to which children's early childhood experiences may or may not have impeded or enhanced the acquisition of skills necessary for understanding and communicating about space.

The research findings, evaluated according to existing and emerging theoretical perspectives on graphicacy, will help to illuminate the current situation regarding the graphic literacy of South African primary school children. The study may contribute to wider international debates about graphicacy as a form of communication and the development of graphic literacy, from a South African perspective.

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For my husband Rob, and children Geoffrey and Kirstin, who sacrificed much in the course of my studies. They were patient through stressful moments, and without their loving support and belief in my abilities, I would not have completed the task.

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CHAPTER ONE
INTRODUCTION

1.1. BACKGROUND TO THE STUDY

Formal education is seen as having a vital role to play in the development of individuals who are fully equipped to function effectively both in the present and in the future world. Primary education should play an important supporting role in this by ensuring that a solid foundation is laid on which all subsequent education can build. It is argued that two essential goals of primary education are

- the development of an individual's sense of identity with and in the environment through which an individual is able to understand who he/she is, where he/she comes from, what his/her place is like, how it is organised and connected and where he/she fits in to the pattern that emerges (Mays 1985; Catling 1988; Catling 1989; van Harmelen & Rozani 1995);
- the development of the individual as an effective communicator. In order to make sense of the world, a child needs information about the world and he/she needs to communicate with others in the world (Balchin & Coleman 1965; Christie 1990; Seels 1994).

Children of today inhabit a multi-dimensional world, and in order to communicate effectively in it, they need the ability to utilise four forms of communication. Literacy, numeracy, oracy and graphicacy are seen as the "four aces" in the "pack of education" (Balchin & Coleman 1965: 85). It is claimed that education is incomplete if any one of the four aces is left out of the pack. Words, numbers, and drawings are neither inferior nor superior to each other as forms of communication; they are simply more or less suitable for particular purposes. Balchin (1985: 8) claims that "in a brain as highly evolved as that of a human being, the potential for all types of ability in communication is inborn but none of them can come to full fruition without education." Teaching children to communicate is the foundation on which education rests. As such, the process should begin on the day a child enters school.

Graphicacy is defined as "the communication of spatial information that cannot be conveyed adequately through verbal or numerical means alone" (Balchin 1985: 8). Information about space can be communicated in a variety of ways, including physical gestures and verbal statements. Frequently, however, spatial information is conveyed graphically. Graphicacy is seen as a complex form of communication in that it utilises some form of symbolic language to convey information about spatial relationships. Graphic representations include maps, photographs, pictures, diagrams. cartoons, sketches, posters and graphs. Within the primary school, pictures are the most common form of graphic representation which children encounter.

Pictures offer the most concrete representation of reality in two dimensions. Pictures are particularly useful for introducing and developing the graphicacy skills requisite for dealing with more complex graphic documents such as maps which children will encounter at a later stage in their primary school career. Despite their seeming simplicity as the oldest and most basic form of graphic communication, Boardman (1983) claims that pictures and photographs, like maps, present numerous perceptual and conceptual problems for children. Although many authors stress the importance of teaching children to read and understand pictures, it is claimed that pictures are the least researched and understood form of graphicacy (Boltt & van Harmelen 1995). In South African primary schools, as is the case in many countries, the emphasis is on oracy, literacy and numeracy with graphicacy being the "discard" (van Harmelen & Boltt 1995).

Fien (1988: 125) highlights the importance of graphicacy as a basic skill, the acquisition of which not only enables one to read, but to interpret and convey information in graphic form. Just as importantly, graphicacy as a 'life skill' must be taught in such a way as to empower the learner to scrutinise, question, challenge, evaluate and judge the message being conveyed.

Graphic communication permeates every sphere of the modern world and it is being used ever more widely and at increasing levels of sophistication (Try 1981; Gillespie 1993; Glasgow 1994; van Harmelen & Boltt 1995). If we accept that children of today are increasingly bombarded with visual information in the media, on television and the computer screen, then we can no longer afford to neglect graphicacy as a form of communication in the primary

school. The introduction of information technology, more specifically the Internet, electronic text and atlases, CD-ROMS and multimedia learning kits into South African primary schools, creates a further need for graphic literacy. So too, with the infusion of Technology Education, there is a need to ensure that children are able to communicate effectively in the graphic form and that they acquire the graphic skills necessary for doing so.

If we are to ensure that children are equipped with the abilities necessary to operate effectively in the modern world, then we need to introduce an explicit and critical pedagogy for teaching graphicacy skills in South African primary schools. If we are to design and implement programmes to achieve this, there is an urgent need to investigate children's spatial perceptual and spatial conceptual awareness and understanding.

1.2. PROBLEM IDENTIFICATION

This section explains:

- three events which acted as a springboard for and influenced my decision to investigate graphicacy as a form of communication in the primary school;
- how this investigation relates to a broader South African educational context and why it is relevant and appropriate in the context of transformation in South African education;
- how this research relates to education within an international context.

According to Morse (1994: 220) "the key to selecting a qualitative research topic is to identify something that can hold one's attention over time." It should be something that is of **real** interest to the person. Three events influenced my choice of the topic for this research, all of which may be viewed as what Morse (1994: 220) refers to as "a significant experience that occurs in the course of everyday living." These three events were linked to issues of personal, national and international educational interest.

1.2.1. The personal interest

The first event took place during a routine homework reading activity with my 10 year old son in April 1996. The story being read focused on the development of canals as a means of transportation in England. Interspersed within the written text were pictures of canals, overhead waterways and locks. Some of the pictures did not 'match' with the description provided by the written text. As such the pictures became a source of interest, intrigue and confusion to my son.

Both as a mother, and as a person involved in geography in education and teacher education, I became fascinated by the way in which, firstly, he 'read' the pictures, and secondly, how he interpreted or made sense of the pictures in the light of the accompanying written text; what skills he utilised in order to do so, and the level of sophistication at which he utilised and applied these skills. This provided the **real** interest which Morse (1994) refers to. *How* do children make sense of the graphic forms of communication which they encounter during the course of a school day, and what sense do they make of them? What skills do they utilise? How do they acquire these skills? What assumptions do teachers make about children's ability to make sense of pictures? Do all children possess and utilise the skills necessary for reading and interpreting pictures? My mind was swamped with questions for which I had no answers. The seeds of interest and the desire to know more were thus planted.

1.2.2. The national interest

During 1996, documents emanating from the National Department of Education articulated a new vision of education and training and a framework for realising it within a fledgling democratic South Africa. The *Curriculum Framework for General and Further Education and Training Draft Document* (July 1996) states: "The vision for South Africa encompasses a prosperous, truly united, democratic and internationally competitive country with literate, creative and critical citizens, leading productive, self-fulfilled lives..." (p 5). The document stresses that education and training has "a special contribution to make regarding the development of the basic knowledge, skills, understanding, abilities and values necessary for

functioning in a changing, modern society" (p 18). Essential outcomes which need to be developed in all learners include: "the ability to communicate effectively across a range of contexts using visual, mathematical and language skills" (p 18). Essential outcomes are viewed as generic; they "should inform all phases, all bands and all areas of learning" (p18).

The *Curriculum 2005 Discussion Document* (March 1997) sets out specific outcomes which are informed by the critical outcomes for each of the eight learning areas. Both the Human and Social Sciences and the Natural Sciences Learning Areas with which geography is associated emphasise the importance of communication, including graphicacy. Extracts from the document (see Table 1.1.) provide a more detailed description of the graphicacy requirements for the Human and Social Sciences Learning Area.

If the goals of the new curriculum are to be met, then graphicacy as a form of communication *as it exists* at the present time, needs to be investigated within the context of multilingual and multicultural South African primary schools. For graphic literacy to be an achievable outcome of the new curriculum, we need to identify and describe the skills and concepts underpinning this form of communication. We also need to establish how these skills are acquired by or developed in our young learners, as well as the factors which may impede or enhance the acquisition of graphic skills and concepts. These are the issues which this research aims to investigate. The specific field of enquiry is the way in which primary school children interpret the world through pictures, the form of graphic representation most frequently encountered by young learners.

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(2) Ability to make informed judgements is demonstrated.	The ability includes: • clarification of attitudes and values (e.g. recognition of different perspectives on an issue) • distinguishing between conflicting values • empathising, i.e. understanding people's behaviour in the context of their circumstances, both past and present (e.g. suspending premature and uninformed judgements of other people's behaviour; appreciating the opportunities and constraints facing people in different situations) • evaluating the merits of different perspectives.
(3) Competence in the application of graphical techniques is demonstrated by : • accessing and interpreting graphically represented data • representing data graphically • translating data from one form of graphical representation to another • analysing graphically represented data • considering the problems of relevance and bias in graphically represented data • using graphically represented data.	Types of graphical representation, to include: • graphs (e.g. pie, line, bar); flow diagrams, illustrations (annotated and other); cartoons and other drawings; photographs (vertical, oblique and orthophoto); time lines; maps (e.g. of different scales, areas subject matter, times/dates, areas, showing contours, sketch and accurate)etc. Interpretation, to include: • decoding of symbols and signs • recognising shapes and features from different perspectives • using a key • reading maps(e.g. using scale to measure distance; finding direction and fixing position; using contours to identify landforms and features). Analysis, to include • relationships and patterns (over time and space) rates of change. Uses: Making • inferences • decisions • recommendations • evaluations. Explanation, to include • proposed routes and other developments • impacts of events in the past • changes over time • differences/similarities from place to place.

Table 1.1. Detailed description of graphic knowledge and skills to be developed in the Human and Social Science Learning Area (Source: Curriculum 2005 Discussion Document, March 1997)

Further, this study will fill a perceived gap in research in geography in education. Previous research in graphicacy has adopted a narrow focus in that it has mainly concerned itself with mapwork problems experienced by secondary school children (Burton 1986; Ndlwana 1991;

Schurmann 1992). In addition, Spatial development has been investigated within a primary mathematics context (van Niekerk 1996); the visual literacy skills of disadvantaged children from informal settlement has been investigated from a Fine Arts perspective (Griffiths-Myers 1997); and the use of visuals in language teaching has been investigated (Blacquire 1987; Benjamin 1989; Lanham 1990).

1.2.3. The international interest

The rise of information technology and the utilisation of programmes and packages which contain increasingly sophisticated graphics, has led to a re-evaluation of the importance of graphicacy in primary education in Britain (Matthews 1992). Recent work carried out in Britain and the USA on children's graphic abilities has challenged certain assumptions on which conventional ideas about education rest. Most importantly, the orthodoxy of Developmental Psychology perspectives has been challenged. There is a growing body of opinion which suggests that Piagetian age and stage theory of cognitive and spatial development may have underestimated young children's competencies (Spencer *et al.* 1989; Matthews 1992; Spencer 1995). For many years the Piagetian contention that children develop sequentially and according to age-related stages has guided or perhaps mis-guided thinking about children's spatial knowledge and skills. Uncritical acceptance of this theory has influenced curriculum design and may well be the reason why graphicacy has been a neglected skills area, relegated to the position of the discard in the pack of education.

Increasingly, research findings are suggesting that graphicacy skills can be taught from the day a child enters school, and furthermore that graphicacy should be given as much prominence within the early school curriculum as numeracy, oracy and literacy (Matthews 1992). More attention has focused on how children construct environmental knowledge from both their direct experience of the environment and through their indirect experience of it from secondary sources such as the media and graphics. Graphicacy is now recognised as an accepted part of the primary curriculum; graphicacy skills are seen as needing to be taught; there is evidence which suggests that children who have been taught graphicacy skills explicitly have benefitted from the experience, and that teaching needs to begin as soon as a child enters school.

Each of the above interests represented a fragmented and embryonic research interest which together metamorphosed into a **real** research interest about which a story could be written. I had reached what Janesick (1994: 210) refers to as the "critical beginning point." I was ready to start formulating these interests into questions for inquiry.

1.3. THE GOAL OF THE RESEARCH

The goal of this research is to investigate graphicacy as a form of communication in South African primary schools. However, given the scope of a research project of this nature, it was decided that rather than dealing with graphicacy *per se,* pictures as the most frequent and concrete type of graphic communication encountered by young learners would be focused on. In seeking to investigate pictures, the study is concerned with diagnosing and illuminating children's graphic skill development through identifying: what skills they use; how they use and apply these when communicating through and interpreting symbols; and the difficulties they experience when, firstly, encoding spatial information through a series of practical and drawing tasks; and secondly, when reading and interpreting pictures.

The purpose of the research is to "accumulate sufficient knowledge to lead to understanding" (Maykut & Morehouse 1994: 174); understanding which may be of value to debates about the design and implementation of meaningful and relevant teaching and learning programmes through which the goals of the new curriculum can be met. In critically evaluating the current theory underpinning education in general, and spatial perception and cognition in particular, this research might also contribute to an evaluation of the worth, relevance and appropriateness of existing approaches to teaching and learning in our primary schools.

The research findings, which will be evaluated according to existing and emerging theoretical perspectives on graphicacy, will help to illuminate the current situation regarding the graphic literacy of South African primary school children. The study may contribute to wider international debates about graphicacy as a form of communication and the development of graphic literacy, from a South African perspective. It is also hoped that the findings of this study will point to areas for further investigation.

1.4. LIMITATIONS OF THIS STUDY

This study does not claim to be tell a complete story of graphicacy; rather, it attempts to provide a rich description of a particular form of graphicacy, as it exists at a particular time and within a particular context. It is acknowledged that because of the restricted scope of the study, caution should be exercised in extrapolating and generalising its findings. The findings must be seen as tentative, being both context and gender specific.

1.5. THE STRUCTURE OF THE STUDY

Chapter Two deals with a critical analysis of the theory which informs the study.

Chapter Three identifies, describes and evaluates the methodology applied in this study.

Chapter Four provides an analysis of data obtained from the first diagnostic activity conducted with the entire Standard Three class, which formed part of the first stage of the investigation. The discussion of the findings is interwoven with the analysis.

Chapter Five deals with the analysis of the data obtained from the second diagnostic activity conducted with the entire Standard Three class, which together with the first diagnostic activity constituted the first stage of the investigation. The discussion of the findings is interwoven with the analysis.

Chapter Six deals with the second stage of the investigation, namely the interviews with the purposive sample.

Chapter Seven presents an evaluation of the findings of the study as well as the conclusion and recommendations of the study.

CHAPTER TWO
THEORY INFORMING THE STUDY

2.1. INTRODUCTION

This chapter offers a critical analysis of the theory which informs the study. The premises of the argument informing the research are outlined in Fig. 2.1. This chapter is structured around these premises and the argument will be developed by looking at them from various theoretical perspectives. The diagram shows that the argument will indicate how, through formal education, an individual's development of a sense of identity in and with the environment is fostered. Knowledge of the environment is seen to be acquired through both the individual's own direct experience of place and space and as a result of indirect experience from secondary sources (Matthews 1992). As social beings, individuals need to communicate information about their environment. This is done through four modes of communication. It will be argued that formal education has an important role to play in teaching the skills necessary for all forms of communication.

Literacy, oracy, numeracy and graphicacy are shown as the four modes of communication. Spatial information about the environment is most frequently communicated in the graphic mode. Fig. 2.1. reveals that an understanding of space is linked to both spatial knowledge (conceptualisation) and spatial perception. Graphicacy is underpinned by a complex and interconnected network of spatial perceptual and spatial conceptual skills. Graphicacy at present is a neglected skill area. If graphicacy is to be recognised as an essential mode of communication and, as such, a vital element in education, then we need to seek ways of developing and introducing an explicit and critical pedagogy in our schools, to foster the development of graphic and critical graphic literacy. But first, the skills and concepts integral to graphicacy need to be identified and understood.

Further, Fig. 2.1. shows the empirical dimension of this research: namely, that we need to investigate how these skills are utilised by children when they both encode and decode spatial information about the environment, and we need to identify the difficulties they experience when doing so. Theories of development and learning which both inform and shape current practice need to be evaluated in the light of the above.

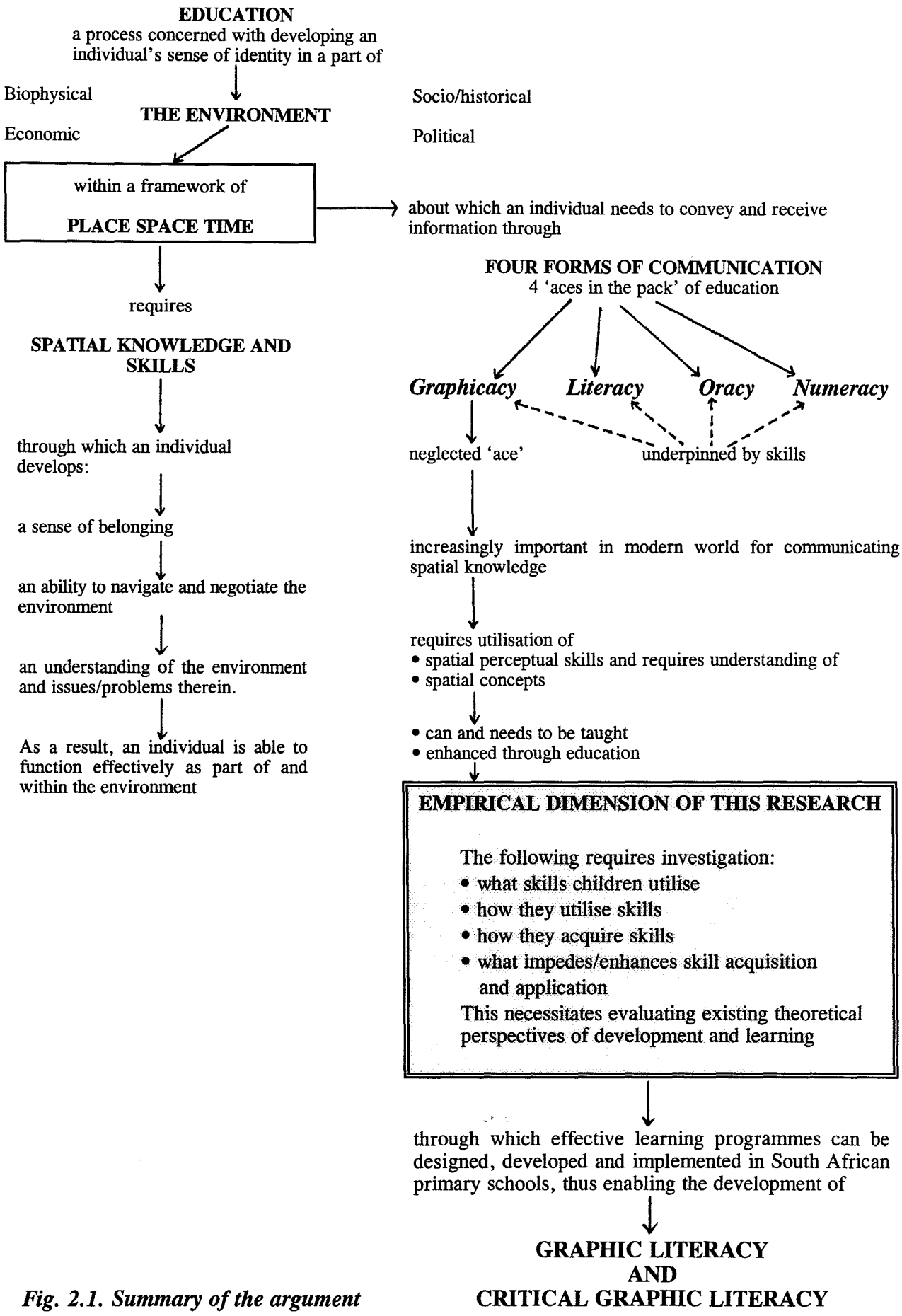

Fig. 2.1. Summary of the argument

This study investigates the skills children utilise when both encoding and decoding spatial information through a variety of activities, including drawing and reading and interpreting pictures; it seeks to illuminate and describe how they utilise and apply graphic skills as well as the factors which enhance or impede their ability to do so.

2.2. THE DEVELOPMENT OF A CHILD'S SENSE OF IDENTITY

All human beings exist within and are part of an environment. It is argued that from the moment of birth, a child starts to make sense of the environment, largely out of the necessity of knowing where to obtain the things on which his/her survival depends. Of great importance is the development of a sense of place, without which people would possess no sense of home, no sense of familiarity or novelty in a place, no sense of recall or anticipation of a place, no ability to move thoughtfully around the environment or to relate to places other than their own, no curiosity about the world, nor any concern for the environment. It is suggested that without a sense of place human beings could not survive or grow (Catling 1988). Further, children are seen as developing a sense of space as they become aware of order and relationships among phenomena in their environment. They start to develop a sense of time, too, attaching meaning to words that they hear. Words such as behind, in front, underneath, before, after start to take on temporal and spatial dimensions (Mays 1985: 42-44).

Importantly, children are not passive inhabitors of their environment; rather, they are active perceivers, interpreters, explorers, initiators and creators of their environment. This is done through their first-hand experience of their immediate environment, through their construction of it in play and through its re-construction in their imagination. As they mature, they become more aware of who they are, what places are like, where they are in relation to other people and phenomena in their environment, how they fit in and how space is used. (Catling 1988; 1989).

By exploring the world and coming to know and make sense of it, a child begins to develop a sense of identity both as an individual and as a member of a community in the world. Mays (1985) claims that a person's ability to successfully negotiate the day-to-day world in

which they live, work and play, is dependent on their capacity to make sense of the world around them. Van Harmelen and Rozani (1995) maintain that in order to function effectively as individuals and as members of a society, children need to understand where they belong, how they fit into the world, how the world functions and how the past has influenced the present.

Although as individuals children begin to develop and construct perceptions and cognitions of the world from a very early age, these are dependent on their experience of the world and it is influenced by their culture and upbringing. As members of a society, children also gain an understanding of the world through shared meanings. Knowledge is both individually and socially constructed. Different children will have different perceptions and cognitions of the world. It is claimed that:

> Environments of childhood vary in scope, complexity and significance. They consist not only of spatial and design attributes, like objects, length, size, shape, distance and scale, but also of meanings, provided by prevailing social, cultural and organisational systems. In a sense these spatial and design features represent the geographical environment, those aspects of the setting that exist as objective characteristics of places. Meanings on the other hand, define a behavioural context in which a child makes sense of or gives significance to a particular environmental transaction. Both these qualities exert a particular power and affect of their own. Not only does the environment condition and shape experience, but also how a child reacts, responds, feels within a particular environmental setting will be a product of the surrounding social, cultural and organisational systems. There is a third dimension, too, which impinges upon this close interrelationship between space and meanings and this is the capability of the child as a processor of environmental information. Every child brings to a situation an arrangement of personal resources and a varying level of environmental skill. Hence, different individuals will react differently to the same environment.
>
> (Matthews 1992: 5)

Individuals are thus seen to contribute, to a greater or lesser extent, to their acquisition of spatial knowledge through primary or physical experience, on the one hand, and their negotiation of meaning-learning cultural codes, on the other. The latter often takes the form of secondary sources such as pictures, photographs and diagrams, all of which are very important for developing awareness and understanding of places - especially distant places which one has not directly experienced. However, the sense children make of secondary

sources of information about the environment is "mediated by their own complex transactions with space and through their own social and cultural lenses of experience" (Matthews 1992: 66). If these claims are valid, then it must be inferred that formal education has a critical role to play in the development of a child's sense of identity in and with the environment.

2.2.1. The role of education

In recent years much interest has focused on how children as active cognitive beings search for, select, remember and construct knowledge of the environment (Clay 1991). A number of claims have been made which are relevant to this study. Children, as unique beings, develop knowledge of the environment from their perceptions of and interactions in and with the environment. Their knowledge is shaped by the nature of early childhood encounters with 'significant others', most notably parents, and by the experiences and opportunities afforded to them as social beings within a particular culture and society. Different societies accord different values to aspects of the environment, and thus one's culture acts as a filter and frame of reference for coming to know the environment. Historically, formal schooling within the context of a Western cultural tradition has viewed non-Western cultures as deprived and 'backward'. This perspective has been challenged and changing understandings of 'culture' have resulted in the recognition that society comprises a plurality of groups, each with its own 'ways of seeing' and experiencing the world. The challenge for schools is to recognise and understand that children see and know the world in different rather than deficient ways. Teachers are seen as having an important role to play in encouraging open dialogue and discussion in the classroom through which children may become conscious of what and how they see, and of how they come to know the world; become aware that others see the world differently, and that through discussion and negotiation, shared meanings are possible. Formal schooling is seen as having an important role to play in teaching children that there are many ways of knowing and interpreting the environment.

Formal education, as a process with life-long implications, has a vital role to play in fostering the development of the child's sense of identity with and in the environment. Formal education should enhance children's maturing understanding, it should broaden and

deepen their experience and knowledge and enable them to become more effective perceivers, users, appreciators, evaluators and developers of places (Catling 1987). The emphasis in education is increasingly to help children towards an understanding of themselves and of their society (Mays 1985). Formal schooling should equip children with the capacities necessary to make sense of their world and it should ensure that they acquire the skills required to communicate and share their ideas, knowledge and feelings with others in that environment. According to Catling (1989), the acquisition of the concepts of community, place, space and time are essential to the development of a sense of identity, enabling individuals to understand who they are, where they come from, what their place is like, how it is organised and connected, where they fit in to the pattern that emerges. Further, it is suggested that, equipped with an understanding of these concepts, people can begin to care about the local and global environment: about other people and communities, and about the natural world on which they depend (Catling 1989).

Van Harmelen and Rozani (1995) concur with Catling (1989) that these four concepts constitute the foundations for much of the sort of thinking that will be required of children as they proceed through school and are required to understand subjects such as science, biology, history, geography and mathematics. Unless these are developed at an early age, children will have difficulty in relating to their own environment and to the environments of others. It is claimed that the most appropriate time for children to acquire these concepts is in the Pre-Primary and Junior Primary phase, whilst they are still at the concept and skill learning stage of their development.

Whilst children enter school with experience and knowledge of their environment, they need to be taught how to communicate and interpret this knowledge effectively. Concepts and skills taught in the classroom help children to order and refine their experiences. Within formal school, children are given the opportunity and time to reflect, to test the knowledge they already have, and to carry it further. What they are taught at school should complement and extend what they already know and have experienced (Mays 1985).

Primary education should be concerned with broadening and enriching the experience and knowledge that children already possess within the framework of place, space and time, by

ensuring that the young child acquires the conceptual understanding and the skills necessary to know and understand the world in which he /she exists and of which he/she is a part.

2.3. GEOGRAPHY AS A MEDIUM FOR EDUCATION

Knowledge of the environment comes in different forms, distinguished by subject division in the school curriculum. This knowledge has not evolved overnight but represents hundreds of years of intellectual heritage. According to Mays (1985) it is not possible for a child to come to understand the ideas and concepts embedded in each subject unaided, for he or she does not possess the skills to do so.

Two important themes emerge from recent debates about geography as a school subject. Firstly, the role of geography as a medium for education has been the focus of many international debates (Boardman 1983; Kent 1985; Bailey & Binns 1987; Gerber & Lidstone 1988; de Villiers 1995; Gerber 1995; Rawling & Daugherty 1996; Bailey & Fox 1996). The worth and value of geography has been reaffirmed through the recognition that through learning geography:

- children develop an understanding of the interaction between people and the physical and human environment. Geography seeks to explain the relationship/interaction between these two dimensions within a conceptual framework of place, space and time;
- children develop an integrated view of the world through studying human and physical phenomena as they occur in space and time;
- children develop spatial awareness and understanding of different phenomena through learning to observe, describe and explain phenomena; where they are in relation to other phenomena; they learn to identify and explain relationships that exist between phenomena, why and how these are changing with time and the implications thereof;
- children develop skills and abilities which are common to many other subject areas, such as observation, recording, information processing and communication skills, of which graphicacy is of particular importance.

Much energy has been spent on not only reaffirming and justifying the worth of the subject

but also debating the form and nature of geography within formal schooling; on evolving appropriate approaches to teaching and learning geography that will develop learners as critical, creative and flexible thinkers and effective communicators able to participate usefully in the world both immediately and in the future. This is reflected in the second major theme, the debate about the role of geography as a medium for education for sustainable living.

Fien & Gerber (1986), Fien (1988; 1993), Huckle (1986a; 1986b); and Davey (1995), while acknowledging the need to understand the interactions between the physical and human world, contend that education must include further dimensions. The implications of these for geography need to be considered. There is a growing realisation that we inhabit a planet in crisis, a planet at risk. The message is clear - unless we mend our ways and start to live in a way that is ecologically sustainable, we will not continue to exist as a species on the planet for very much longer. Most importantly, geography:

- ought to promote awareness and understanding of the world in the broadest sense by exploring the links between its human (socio/political, economic and historical) and physical components, in order for children to understand the world as an interconnected and interrelated system. Geography thus needs to be a vehicle for *education about the environment;*
- should develop skills and capacities in children, including critical thinking and the ability to effectively utilise all four forms of communication, namely oracy, literacy, numeracy and graphicacy; so that, through problem solving and decision making, they are able to function in the world both immediately and in their future adult lives. Geography thus needs to be a vehicle for *education in the environment;*
- should promote the development of values and attitudes necessary to sustain life on this planet. These include awareness, concern, care, responsibility, tolerance, stewardship and respect for life. Geography thus needs to be a vehicle for *education for the environment.*

From the above, one may infer that geography has an important role to play in promoting the sort of social change which is necessary for achieving the goals of sustainable living.

This view is underpinned by the belief that existing conditions are unsatisfactory. Unwin (1992: 16) claims that "at its most basic level, the central role of education is to provide people with the means of everyday survival," and geography ought "to tackle some of the most critical issues facing contemporary society" (Unwin 1992: 210). However, this necessitates adopting a critical approach, which means recognising that

> ...people create environments, and we can have no knowledge of environments separate from their human construction. It is this construction that makes places.... Place has become the focus for understanding the interaction of the human world of experience and the physical world of existence. The task of critical geography is to enable people to reflect upon this interaction, and in so doing to create a new and better world.
>
> (Unwin 1992: 211)

Binns (1996) argues that, given the breadth and scope of geography's contribution to education, it ought to be a foundation subject in the primary school. Further, he suggests three goals for geography to aim for. The subject ought to be relevant to all children; to provide all children with an equal chance in life; and to enable them to fulfil their life's ambitions (Binns, 1997 personal communication). If we accept these claims as valid, then the challenge to educators and teachers is how to design curricula and learning programmes which will enable the goals of the subject to be met. How do we ensure that children, through the medium of geography, are equipped with conceptual knowledge, skills and values which will enable them to become more effective perceivers, users, appreciators, evaluators and developers of places? (Catling, 1989).

In the light of the above argument, Fig. 2.1. shows that education has an important role to play in the development of a child's sense of identity in and with the environment, and in the provision of the knowledge, skills and values necessary for sustaining life and for survival in the environment. This study is concerned with the spatial element of geography, that is, with children's development of spatial awareness and understanding as well as their ability to communicate spatial information effectively. Fig. 2.1. reveals the importance of these capacities for achieving the goals of education as argued above. Information about space can be communicated in a variety of ways, including physical gestures and verbal statements. Frequently, however, spatial information is conveyed graphically. Geography

has an important role to play in developing the skills intrinsic to this form of communication. This study is concerned specifically with graphicacy as a means to communicate through the use of symbolic codes of representation. It is argued that whilst children may possess spatial perceptual skills and conceptual understanding, as shown in Fig. 2.1., their ability to use graphicacy as a form of communication is dependent on their ability to apply these skills and concepts through the use of symbols. The question of education and communication requires closer consideration.

2.4. EDUCATION AND COMMUNICATION

Fig. 2.1. indicates that in order to make sense of the world, a child needs information about the world and, as a social being, he/she needs to communicate with others in the world. According to Balchin & Coleman (1965) teaching a child to communicate is a foundation on which education rests. All education should equip children with basic skills of communication. This should be done as early as possible whilst the child is still in the skill-learning stage of his/her education.

2.4.1. Forms of communication

While the human brain has the capacity to utilise four modes of communication, the efficiency and level of sophistication with which it is able to do so is seen as dependent on education. Procedures for each have to be taught (Balchin 1972; 1985; 1996). Balchin (1996: 4) categorises communication as follows:

- of spatial relationships through symbols (graphicacy);
- of spoken language (oracy);
- of written language (literacy);
- of numerical relationships (numeracy).

Graphicacy, oracy, literacy and numeracy are referred to as the four "aces" in the "pack of education" (Balchin & Coleman 1965: 82). Traditionally, a great deal of time in the primary school has been spent teaching the skills associated with oracy, literacy and

numeracy, with graphicacy being the "discard". It is argued that good education should be concerned with the development of all four "aces in the pack." A child needs to be taught how to utilise each of these. Should one be missing from the "pack", the "game" is likely to be impaired (Balchin and Coleman 1965: 82). Further, none of the four are superior or inferior as forms of communication; rather, they are to be viewed as complementary and interchangeable. It is argued that one form of communication, when used in conjunction with another, can enhance and enrich the other. In this way the child's ability to make sense of the world can be enriched (Balchin and Coleman 1965).

If we accept the premises on which the argument developed thus far rests, it follows that in order to develop children as effective communicators of space and spatial relationships, we need to teach them the skills for doing so. There is an urgent need to explore and understand the theoretical underpinnings and importance of graphicacy as a form of communication if an appropriate, explicit pedagogy is to be introduced in the primary school. Besides understanding graphicacy as a particular type of communication, there is a need to understand the similarities and overlap between graphicacy and other forms of communication.

2.5. GRAPHICACY AS A FORM OF COMMUNICATION

2.5.1. Definition of graphicacy

Some three decades have passed since Balchin and Coleman (1965: 82) coined the term *graphicacy* to denote the communication of spatial relationships that cannot be successfully communicated by words or numbers alone. Graphic representations include maps, photographs, pictures, cartoons, diagrams, line drawings, sketches, posters and graphs. All graphic representations are vital within and beyond the learning and teaching of geography; they are playing an increasingly important communicative role in modern society. With the introduction of information technology in our schools, the use of electronic texts and atlases, and multi-media kits with learning programmes on CD-ROM and the Internet, an increasing amount of information is being communicated in graphic form and at an increasing level of sophistication.

Graphicacy, as a form of communication, involves encoding information in some type of graphic representation, which is conveyed to the reader through some or other form of symbolic language. The reader then decodes the representation in order to understand the information being communicated. According to Molyneux & Tolley (1987) and Catling (1995), to develop graphicacy, children need to be given the opportunity to practise both encoding and decoding information. They need experience of drawing graphic representations as well as reading them. Walters, Quinn & Wilmot (1995) concur with these authors and further suggest the importance of talking and discussing graphic representations within junior secondary geography lessons.

It is argued that graphicacy is a complex form of communication in that it:

- utilises some form of symbolic language to convey information about spatial relationships;
- requires that the reader/creator of graphic language possesses conceptual knowledge of the phenomena represented in the graphic representation, as well as spatial perceptual abilities and an understanding of spatial concepts;
- requires practical skills of being able to create graphic forms to communicate information to others.

Of importance to this research is the extent to which children may possess spatial skills and have conceptual development but remain unable to communicate their knowledge through the use of appropriate symbols. If graphic literacy is accepted as a goal of formal education, specifically linked to geography education, then the extent to which children are able to utilise graphicacy as a form of communication when conveying spatial information about the environment, needs to be investigated.

Again, if it is accepted that primary schools must concern themselves with the development of skills, including the basic skills of communication, then there is a need to clarify what is meant by the term 'skills' if meaningful programmes for teaching skills are to be devised (Griffiths 1987). Different people use the word 'skills' differently. To some the word skill denotes a physical activity - a doing, for example drawing a picture, rather then utilising

some or other form of reason. Barrow (1987) claims that one interpretation of skill is the ability that comes from training or practice and which involves minimal understanding. He goes on to say that the word 'skill' in education leads to "a disassociation of educational practice from understanding" (in Griffiths 1987:207), and that there is a danger that understanding, rationality and reason are devalued. Barrow also warns of a second danger, that of organising a curriculum based on the development of generic skills rather than on specific forms of knowledge. Griffiths (1987: 212) argues that such a view of skills would lead to the introduction of skills to students in a way which "reduces them to mindless activities, divorced from theorising and devoid of any serious reflection of any kind." Instead she proposes that 'skills' be viewed in the Rylian sense of 'knowledge how', which incorporates practical knowledge that sometimes requires very little reflection and at other times requires a great deal of reflection (Griffiths 1987: 210).

The teaching of skills requires an understanding of children's development and of how learning takes place. As a starting point, we need to investigate what prior knowledge, ideas and attitudes children possess. No child comes to school as a *tabula rasa*, all children actively construct knowledge based on their experiences. This may well reveal mis-information, confusion, misconceptions and prejudices; it is only through identifying these that we may begin to design meaningful learning programmes. We need to establish what we need to teach to compensate, remedy or enhance that which the child already knows and can do. Within our multicultural and multilingual context, the situation is especially complex; for not only do we have children from different backgrounds and child-rearing practices, but we are also faced with an increasing number of children whose freedom of independent movement in the environment is restricted, for a variety of reasons. Ward (1995) draws our attention to the negative effects of urbanisation on British children who are restricted in their freedom to play, explore, cycle and walk unaccompanied in the environment for fear of danger. As a result, schools are faced with an increasing number of children who are not developing the same sense of 'belonging', of 'whereness', of forming connections with places, as their parents and grandparents did. An increasing number of South African children depend on being transported to and from school by means of taxis and motor cars. Many of them are growing up in areas characterised by violence and high crime rates, while others are growing up in homes surrounded by high security

fences. Within the present South African situation, children may well be experiencing an even greater sense of alienation from their environment than that described by Ward. It may well become the role of the school to provide the opportunities necessary for the development of spatial awareness and understanding that previously were taken for granted as a natural part of the child's informal education.

2.5.2. Current trends and thinking in graphicacy as literacy

The concept of literacy has expanded in recent years because of the increasing demands of a technologically advanced society. Literacy is seen as embracing many aspects, including computer literacy, media literacy, visual literacy, environmental literacy, political literacy. It is important to develop all of these if a person is to be equipped to function effectively and responsibly in society (Seels 1994).

Debates about the changing nature of literacy in the modern world have unfolded internationally (Cherryholmes 1988; Delpit 1988; Christie 1990; Martin 1993; Cope & Kalantzis 1993; Glasgow 1994). It is claimed that to be literate in the contemporary world:

- is to understand the very large range of written forms or text types (genres) which people need to be able to read and write in order to participate fully in the community;
- is to learn to recognise and create the various forms found in one's culture;
- is to be a resistant and critical reader who has been taught how to examine the ways in which the form works in building and ordering meanings. This is seen as important, for not only must an individual be able to operate effectively in society but he or she should be capable of working towards change within society, should this be necessary.

(Christie 1990: 1-19)

Within literacy debates, the new developments have usefully been described as follows:

> What do I mean by the term 'literacy' and the 'new literacy'? I mean by literacy the ability to communicate through the three modes: reading and writing, speaking and listening, visualising and observing - print, audio and visual literacy. This literacy, broadly speaking, can be at two levels. First, it is at the level of training, initiative reaction. Here we communicate the simple, literal meaning of what is said, written or visualised... Or second, we can have creative interaction, can read between the lines, draw inferences, understand the implications... We thus learn what the speaker, writer or visualiser 'meant to say' which requires a greater degree of literacy. And finally, we learn to read beyond the lines, to evaluate, and apply the material to new situations. We use the message in our own varied ways... The new literacy involves **critical reading, critical listening,** and **critical observing** (emphasis mine).
>
> (Dale, as quoted in Seels 1994: 98)

The significance of these comments for graphicacy needs to be recognised. A 'graphicate' person may be viewed as one who has been taught how to read, interpret and understand graphic texts critically. In order to do this, children need to be taught the procedures necessary to read and interpret the various graphic representations and also to question and challenge the message that is being communicated through the graphic text. Through this process of de-construction and re-construction, they should be taught that no graphic representation is value free or neutral, but that each conveys a message which reflects the creator's interpretation of reality; that this is not the only one, nor is it necessarily the correct one. Children need to understand that the frame of reference one acquires by being a member of a society provides both a filter for, and restriction on, the sense they make of the world (Muffoletto 1994).

Proponents of the visual literacy movement claim that there is a need to teach visual skills, for just as one finds meaning in written texts through studying the composition, syntax and elements of the text, so too one finds meaning in visual texts (Hortin 1994). Further, it is claimed that the teaching of visual texts should take place at a young age because of the danger of viewers being manipulated by the media:

> I think very early on students need to be educated into the idea that images speak, that images say certain kinds of things and that there are values and priorities and meanings embedded in images and that they need to learn something about the vocabulary and grammar of images to be critical. I think what's valuable about that - making visual literacy a basic part of education - is

> it will take materials which are primarily directed at the emotions and the senses and it will reposition them within the framework of critical reasoning and thought.
>
> (Miller, as quoted in Seels 1994: 108)

Whilst most people may be able to 'see' and 'read' visual material as well as react to it, on another level they need to develop a critical understanding of it, and this requires instruction (Hortin 1994). The many strategies for teaching literacy are applicable to the teaching of visual literacy (McGee & Richgels 1990). Despite this, visual literacy has remained a neglected area of communication in the school curriculum, perhaps because not enough is known about how to teach it (Dondis 1973). The question of what mental skills are necessary to make sense of visuals remains problematic. There is a danger that in attempting to teach the technical skills, the underlying graphic skills might be neglected. The latter include spatial perceptual abilities and spatial conceptual understanding.

A closer analysis of oracy and literacy reveals that both literacy and graphicacy differ from oracy in that they utilise texts (albeit verbal as opposed to visual), which are produced in a context removed by time and distance from those in which they are read. The writer/creator of the text does not interact with the reader, and so does not depend on a shared context to convey the meaning of the text. The meaning has to be contained in the text itself. The reader has to be taught to make meaning of the text and this requires him/her to know and understand the grammar or logical arrangement and organisation of the text (Hammond 1990).

Parallels can be drawn between current debates concerning the changing nature of literacy and those occurring within geographical education. Fien (1988) argues that geography ought to contribute to education through the development of political and environmental literacy or "skills for living". This requires adopting a socially critical approach to education. Geography has an important role to play in preparing young people to participate in choosing the sort of society in which they would like to live. This can best be achieved through helping children to work towards such ends; by teaching them to challenge any injustice and irrationality in the way in which they perceive the world to work at the present time. Achieving such "skills for living" requires re-formulating what are perceived to be

the basics of education, namely literacy, numeracy and graphicacy. Fien calls for a broader view of these three forms of communication to be taken.

> Literacy in the fullest geographic sense involves understanding a range of choices and preferences in order to read, analyse, clarify and interpret one's own and other peoples' values, interests and point of view. Likewise, a wider view of graphicacy and numeracy would seek to promote an ability to question, to read assumptions, to detect limitations expressed in words, numbers or diagrams, and to go beyond the information given.
>
> (Fien 1988: 125)

Fien highlights the importance of graphicacy as a basic skill, the acquisition of which not only confers the ability to read, interpret and convey information in graphic form. More importantly, graphicacy skills, as 'skills for life', must be taught in a way that empowers the learner to scrutinise, question, challenge, evaluate and judge the message being conveyed. If we accept Fien's view that geography should promote critical graphic literacy, then we need to seek ways of teaching it in our classrooms. Further, we must ensure that the basic skills of graphicacy are acquired as early as possible in a child's primary school career, so that as the child progresses through school, these may be utilised and built upon. Designing and implementing relevant and meaningful learning programmes from which all the children in South African classrooms might have an equal opportunity to benefit, requires that we investigate children's spatial awareness and understanding. This includes investigating the skills our children utilise to communicate graphically, the level of sophistication at which they utilise graphic skills, and the manner in which they utilise these skills to make sense of the graphic representations which they encounter in the course of their daily school lives.

2.5.3. Identifying the skills of graphicacy

Spatial perception and spatial conceptualisation are the foundations on which graphicacy rests. Understanding graphicacy requires an understanding of children's perceptual abilities and spatial conceptual development (Boardman 1976; 1983).

2.5.3.1. Spatial perception and spatial conceptualisation

Perception is viewed as a complex and ongoing process through which one makes sense of one's experiences. The process is two-fold: firstly, it relates to the gathering of information through the senses about what objects are in the environment and where they are; secondly, it relates to a process of organisation that takes place in the brain so as to order and make sense of the messages conveyed through the senses about the world (Atkinson *et al.* 1993; Bisplinghoff 1994; Stern & Robinson 1994). Because perception involves both a physical process of 'seeing' and an intellectual one of interpreting, it is bound up with the development of cognitive skills. It is only by means of thought processes that a child remembers and recognises objects that he/she has seen, heard, tasted or touched (Grove *et al.* 1989).

Spatial perception relates to how an individual perceives space. Space is a concept that exists in the mind and permits the structuring of relationships between objects in the world. It includes an understanding of words such as above, below, near, far, behind, large, etc. Space is subjective and relative and depends on the way in which different people structure it at different times (Boardman 1983; Spencer *et al.* 1989).

According to van Harmelen & Boltt (1995) spatial perceptual skills comprise the ability to:

- recognise objects in the environment. This we do through our ability to recognise and identify relationships among shape, colour, size, pattern, texture;
- recognise the 'right way up' of objects; the ability to orientate ourselves in the world and to orientate objects in relation to ourselves and/or other objects;
- transfer 3-dimensional space into 2-dimensional forms;
- recognise that real objects are constant in shape, size and colour (perceptual constancy), but that they may appear distorted when represented from unusual views or when transferred into 2-dimensional form;
- recognise depth and distance/proximity;
- identify perceptions of elevations including vertical/aerial, oblique and horizontal/normal views; and

- identify and understand relationships of location/position, scale and size.

Space is a critical aspect of the environment in which human beings must operate. We need during the course of our everyday existence to navigate through space, and our capacity to do so is dependent on our ability to perceive and understand spatial relationships (Wickens 1992). According to Catling (1989), at a perceptual level children need to show an awareness of where phenomena are located in the world. This then develops into a recognition of how phenomena are arranged and thus an appreciation and understanding of the relationships that emerge. In other words, the child must be aware of, interpret and make sense of his/her percepts.

Spatial conceptual skills are identified as the ability to:

- categorise and reduce the complexity of the environment;
- organise, categorise, structure/order and interpret/make sense of one's percepts of what objects are, where they are, and how and why they are such;
- identify, describe, analyse, explain, and justify objects and relationships of both a concrete and abstract nature; and
- acquire, organise, store, recall and decode information obtained about the relative location and attributes of objects and phenomena in the external environment, by means of a 'cognitive map'.

(Graves 1975; Hall 1976; Yelon & Weinstein 1977; Catling 1989; Grove *et al.* 1989; Wickens 1992; Atkinson *et al.* 1993; Golledge *et al.* 1995)

Whilst it may be convenient to distinguish between spatial perceptual and spatial conceptual skills, it is nevertheless important to see them holistically, for each influences and impacts on the other and an individual's spatial knowledge is largely a result of the interrelationships that exist between the two components. Fig. 2.2. indicates the skills underpinning spatial perception and how these are linked to spatial concepts. Importantly, the diagram suggests that the ability to communicate spatial knowledge is dependent on the extent to which an individual has both spatial perceptual skills and spatial conceptual understanding.

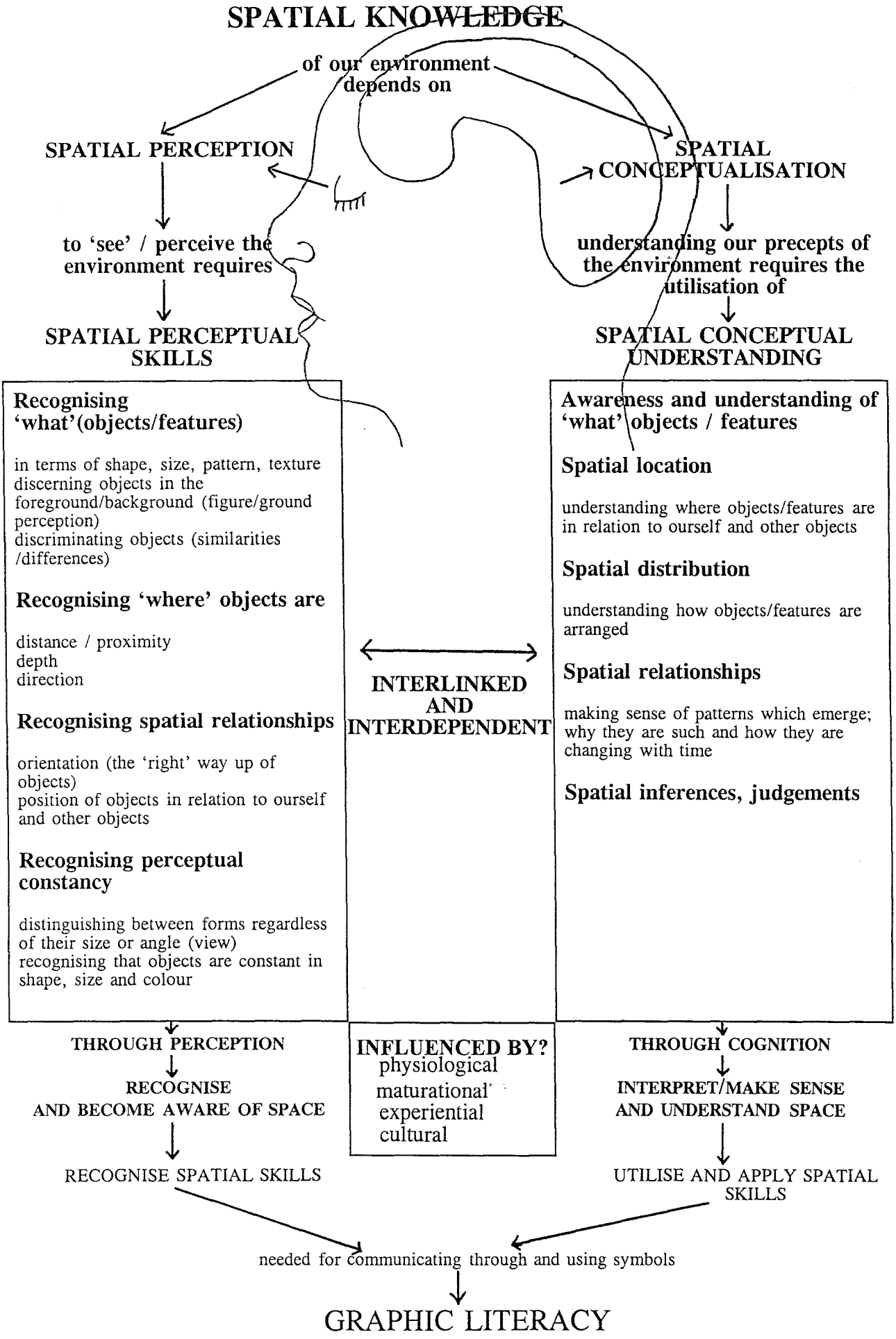

Fig. 2.2. Spatial perceptual and spatial conceptual skills

Fig. 2.2. suggests that if spatial perceptual skills are poorly developed, an individual will not be able to develop spatial understanding. Conversely, if spatial conceptual understanding is poorly developed or lacking, then an individual will not be able to utilise and apply spatial perceptual skills efficiently. To communicate spatial information effectively in graphic form requires that an individual not only recognise and utilise spatial perceptual skills but also have the ability to apply these skills. The latter requires spatial conceptual understanding. Further, it also requires that an individual has the necessary hand-eye co-ordination and fine motor skills to execute a drawing.

The importance of the interconnectedness and interdependency of spatial perceptual skills and spatial conceptual understanding as shown in Fig. 2.2. should not be underestimated. Barrow (in Griffiths 1987: 207) has alerted us to the danger of interpreting the word 'skill' in a way that leads to "a disassociation of educational practice from understanding", which might lead to a devaluation of understanding, rationality and reason.(see Section 2.5.1. for a more detailed discussion).

Of significance to this study is the contention that unless a child has a certain level of spatial perceptual skill competency **and** spatial conceptual understanding, he/she will battle to cope with the demands made by formal schooling. Spatial perceptual skills, spatial conceptual understanding and fine motor co-ordination are required for literacy (Grove *et al.* 1989; Clay, 1991), mathematics (van Niekerk 1996), physical education (Gerhardt 1973) and environmental studies (van Harmelen & Rozani 1995).

The pre-primary phase is seen as playing an important role in enhancing the skills which children have developed within the home. Gerhardt (1973) claims that during this stage of schooling opportunities and experiences for spatial perceptual and conceptual development must be provided. This may be done through a variety of activities including physical games and movement, board games and puzzles, reading and talking, pictures and drawings. So too, it is in this phase that perceptual problems need to be identified and remedy through explicit teaching and appropriate activities (Grove *et al.* 1989). It is during the pre-primary and primary phase that a foundation is laid upon which further education either builds or crumbles.

Catling (1995: 11) argues that "an early essential role of geographical work in the primary school is to help children develop the language, and accuracy of use, for location, direction and distance language." Children should be introduced to key spatial concepts including

perspective	:	the view from above
symbols	:	how features are shown
location	:	where features are
direction	:	which way
scale	:	how far; reduction
purpose	:	what is meant to be seen

Molyneux & Tolley (1987) and Catling (1995) stress that graphic skills should be taught and practised through two complementary processes, namely through encoding information in graphic forms such as drawings and maps, and through decoding information through reading and writing activities. Children should be provided with opportunities to both draw and read graphic representations. They need to practise the spatial skills associated with both encoding and decoding information.

Matthews (1992) provides a comprehensive overview of the many ways in which children's maps have been analysed. For the purposes of this study, I was guided by Matthews' (1992: 103) suggestion that "children's maps can be grouped into three levels of competency, each associated with different methods of representation and different abilities to see space in a two-dimensional form." Table 2.1. summarises the three levels.

Level 1:	Pictorial and pictorial forms represent the simplest form of 'map' whereby children simply draw a picture of their environment, sometimes embellished through labelling. Many of the features are drawn as if 'lying down' along a street. Children who draw these maps lack the skill of rotation, which involves an ability to transform environmental information into an aerial view.
Level 2:	Pictorial-plan and pictorial-plan-verbal maps represent a mid-way stage in map development, with the result that horizontal and aerial views are combined. These maps involve some rotation, symbolisation (the process of selecting line, point or area signs to depict spatial phenomena) and scaling.
Level 3:	Plan and plan-verbal maps represent the highest level of mapping competence, and are based on orthogonal transformations of space.

Table 2.1. Levels of mapping ability (Matthews 1992: 103-104)

In a study of 6-11 year olds mapping their home area, it was found that irrespective of age, the general trend was for children to draw hybrid maps combining both pictorial and plan forms. Importantly the study revealed that:

- whilst children as young as six possess the skill of rotation, not every 11 year old has acquired it; such children are thus unable to transform environmental images topologically;
- very few children of ten or older drew maps other than in plan form; and
- most of the older children chose to embellish their maps through some kind of labelling.

According to Matthews (1992: 105) successful map drawing "does not just involve the ability to represent features symbolically, but also the capacity to arrange elements correctly within a spatial structure." In a study of 6-11 year olds, it was found that children's spatial comprehension improved with age, and that by the age of 11 years most children were able to represent space in a highly organised manner (Matthews 1985, in Matthews 1992). Guided by this thinking, I sought to classify the children's maps according to how they drew them and to the accuracy with which they did so.

The diagnostic activities used in this research attempt to illuminate a group of children's spatial perceptual and spatial conceptual skills. These activities reflect the type of activity that should be a integral part of teaching and learning programmes in the primary school. For the purpose of this research children were asked to perform a number of different practical and drawing tasks through which the skills they utilised could be identified and described, as could the nature of their spatial conceptual understanding. This research also used a picture reading activity to investigate the sense that children made of a series of pictures taken from various perspectives. The skills they utilised to read and interpret the pictures were identified, as was the level of sophistication at which they were able to utilise these skills.

2.5.3.2. Development of spatial perception and spatial cognition

The question of how children develop and learn has been the subject of intense and ongoing debate. Wood (1988) and Knight (1993) identify three perspectives, namely those of Piaget, Bruner and Vygotsky, each of which gives rise to different expectations about children's cognition, but all of which are relevant to and inform this study.

Traditionally, thinking about development has fallen within the ambit of Developmental Psychology. Piaget was interested in how children construct knowledge and how their reasoning and thinking changed as they grew and matured. According to Knight (1993) four key ideas of Piaget's have been particularly influential, namely:

- his insistence that development is an active process, not a passive one;
- the postulate that thinking develops in a series of stages which follow an invariant order;
- the demonstration that each stage could be associated with a certain mental age; and
- the claim that there was a unity about stages, so that whatever content a child encountered, the highest level of thinking would be set by the child's stage.

Thus, for Piaget, cognitive development was viewed as innate, sequential, invariant and dependent on maturity. All children are seen to pass through a series of four distinct age-related stages before they construct the ability to reason and to think rationally and logically (Wood, 1988). The four stages of thinking are classified as: sensori-motor (0-2years); pre-operational (2-7 years); concrete operational (7-11,5 years) and formal operational (11,5 years and older). Piaget classified children's understanding of space as consisting of three stages: topological, projective and Euclidean. Thus the understanding of spatial concepts, like thinking more generally, is seen as developing sequentially, becoming more abstract with maturity.

Piaget's theory puts forward a view of the child making sense of his/her perceptual experiences of the world through structures of thought particular to the child's stage of development (Rhys 1972). Within the traditional Piagetian framework of thinking, the pre-

operational and concrete operational stages are relevant to this study. The structure of a child's thinking is seen as progressing from an intuitive, pre-logical grasp of reality to a logically constrained, more realistic view of the world around them at about seven years of age. It is claimed that before seven children cannot grasp the concept of invariance; they do not recognise that operations or mental constructions form logical groups which can be reversed. Piaget's experiment in which children were asked to imagine how a model of three mountains would appear from different viewing positions, revealed that children below seven years were unable to conceptualise or form mental representations of what the objects looked like other than from their own point of view. These findings stressed the ego-centricity of children's thought at this stage of development.

Importantly, despite Piaget's insistence that he was trying to discover how knowledge developed in children's minds, not to offer educational propositions, his theory, as interpreted by others, has informed or mis-informed classroom practice. Boardman (1983), working within a Piagetian framework, developed a comprehensive thesis on how mapwork ought to be introduced and taught in school geography. This was based on Piaget's idea that children do not think in the same way as adults and are not 'ready' for mapwork until the concrete operational stage.

A growing body of research has emerged from Environmental Psychologists working in conjunction with others, including geographers. Much of the research has focused on re-visiting children's spatial conceptualisation; and many of the findings challenge the Developmental Psychology tradition of Piaget (Spencer 1995). The notion that a child's competencies are age- and stage-dependent has been challenged. Conning & Byrne's (1995) research provides empirical evidence of the competencies of 3-4 year olds that challenges Piaget's account of the egocentricity of the young child in perspective-taking.

Work done by Blaut and Stea (as cited in Matthews 1992) found that children as young as three years of age were capable of interpreting aerial photographs, and that this ability was independent of culture, education or location. They suggested that this capacity was an innate and natural one and probably due to the nature of the toys young children played with, such as dinkie cars, through which the children developed the experience of seeing

the world from above and hence from a view different to their own. Whilst this research supports the Piagetian claim that development is innate, that knowledge is actively constructed by children through their natural as opposed to taught experience of the world, it does contest the sequential and age-related nature of development. So too, Blades & Medlicott's (1995) research reveals that young children are able to understand the conventions of a map, and can interpret aerial photographs at a much younger age than that suggested by Piaget. Thus research findings indicate that children's capabilities at a particular age exceed those allowed for by the traditional Piagetian framework. It would seem claimed that the latter has tended to underestimate the skills and potential of young children, tending rather to stress children's 'deficiencies' in relation to adult performance.

Research conducted by van Harmelen and Boltt (1995) on in-service primary school teachers has shown that learning is not sequential. Viewed within a Piagetian framework, many teachers were at the stage of a 4-6 year old. Many lacked the skills and concepts requisite for spatial comprehension and had difficulty in carrying out the required tasks. The research findings challenge the notion that spatial perceptual and spatial conceptual development are innate, sequential and dependent on maturity. From discussions held with the teachers, van Harmelen and Boltt found that prior experience and background, including culture and child- rearing practices, were significant factors in determining the skills and understanding that the teachers possessed. The research findings suggest that people do not just discover for themselves as they mature and corroborate Mays'(1985) claim that it would be a mistake to assume that children's perception progresses steadily from being imperfect and imprecise in childhood to being complete and efficient in adulthood.

The Piagetian view holds that cognitive development cannot be speeded up through teaching, as children in, for example, the pre-operational stage do "not possess the operations to make sense in logical terms of what they are shown" (Wood 1988: 21). Further, a child is seen as not being able to assimilate what is taught or done until he/she has the cognitive structures necessary for doing so. Assimilation is seen to be constrained by the child's stage of development. Piaget's ideas, as interpreted by others, including educationalists and curriculum designers, have had a significant impact on what is taught and when it is taught in formal school (Knight 1993).

The way in which a child is seen to develop these competencies has been challenged. The cognitive and affective implications of an increased environmental experience, regardless of the child's age, have received greater consideration. Research findings suggest that children who have had a wider range of environmental experiences develop richer skills than those who have not (Spencer 1995). However, changes in the activity patterns of children growing up in environments that are neither as safe nor as unrestricted as they were previously, and the implications of this for skill development, needs to be investigated. If research is to play a meaningful role in curriculum planning, then cognisance should be taken of children's needs in the environment they inhabit and the extent to which they have the skills to meet them. Spencer (1995) cites a growing body of research findings which support the notion that children are more skilled users of the environment than Developmental Psychology has led one to believe. The research methodology and tools of Developmental Psychology tradition have been criticised. The over-emphasis on laboratory-based studies, using models of reality devoid of the rich cues and associations found in the real environment, has been criticised for artificially limiting what children are actually able to do. The findings of increasing numbers of studies of the child's everyday world suggest that children are capable of far more than age and stage theories have led us to believe.

Of importance to this research is the significant shift that has taken place in thinking about children's spatial conceptual development and the methods used to study these. Greater emphasis is now placed on the environment of the child: on the impact of change in the environment on the child's activities and interactions; and on the need for investigations of children to be located within their environment rather than in a contrived laboratory situation. Although the present research was conducted in the classroom rather than the 'real' world, efforts were taken to ensure that the tasks asked of the children were not contrived. In addition, an effort was made to ensure that the design of the research tools was appropriate to the "expressive capacities" of the children (Spencer 1995). This was done by providing the opportunity for them to express their ideas in writing, verbally and through their drawings and maps.

Wood (1988) raises an important question which is relevant to this study: Do young children fail to perform a task as a result of intellectual incompetence (or 'illogical thought' in

Piagetian terms) or because they lack the relevant experience and expertise? Wood's research has shown that children within Piaget's pre-operational stage are seemingly unable to synthesise individual elements into a larger configuration. Children will see the parts of a picture without seeing the larger figure that these suggest. A small minority will see the larger configuration without seeing the more all-embracing figure. Before seven years of age, children tend to 'centre' on either the individual elements or on the overall configuration, but not on both simultaneously. In other words, until the age of seven, children are not able to synthesise meaningful elements into larger units, and in embedded figures they fail to analyse complex forms into their elements. In both these situations, children are unable to perceive a given element as a constituent of two or more configurations at the same time. Such findings appear to be consistent with what Piaget's claim that children in the pre-operational stage cannot grasp that an element of any task or situation can belong at the same time to two or more categories or classes.

According to Wood (1988), as children grow older, they seem to learn or discover the need for imposing some sort of structure and organisation on what they are trying to learn. Children older than 7 years of age seem to make more intelligent use of their past experience and implement strategies which seem likely to enhance their chances of success. One such strategy is the categorical organisation of material by grouping objects into appropriate sets. Whilst this appears to be innate and age-related in that as a child grows his/her levels of attention and concentration increase, it also seems to be aided by the child's encounters with jigsaw puzzles and through following instructions when building Lego and making models. Wood (1988) suggests that young children can be assisted and taught to organise and structure material through a process in which the teacher scaffolds the strategies for the children by setting tasks, arranging materials, reminding and prompting. They can thus be taught to become more skilful at an earlier age than Piagetian theory suggests. Wood (1988) looks at ways in which this can be done. Using the example of pictures and photographs, he claims that both involve knowledge of conventions and learned skills of analysis and planning. Perceiving 3-D objects in 2-D requires that inferences be made about relative size, depth and perspective. Perception of such factors is neither natural or automatic. Many children learn the skills for interpreting 2-D representations informally through using pictures to make things, by looking at family photographs and

through other experiences involving the use of pictorial materials. Children from cultures where childhood experiences such as these are not readily available or practised do not learn to make sense of pictures. Wood stresses the importance of and the need for teaching young children how to attend to and interpret pictures from the day they enter school. He thus challenges the Piagetian assumption that young children cannot be taught tasks or concepts because they lack the structures with which to do so. His view concurs with that of Bruner and Vygotsky, namely, that young children can be taught to do things that they cannot do on their own, but that this depends on the type of instruction they receive.

Unlike Piaget who viewed development as rigid and tied to specific stages, Bruner (1960; 1971; 1986) argued that the basic principles of any subject can be effectively taught to any child in some intellectually honest way, at any stage of development. He claimed that the environment, rather than maturation, was the most significant factor, and that if appropriately structured, cognitive development could be accelerated (Hall 1976).

Bruner rejected the notion that one must wait for maturation, instead emphasising the value of helping children to understand the conceptual structure of the subject. He suggested that such structures were so basic that some level of learning may be achieved at any stage. Observations of the graphic skills utilised by a seven and eight year-old in their drawings revealed that their spatial perception was ahead of where it should have been according to Piagetian stage theory. The spatial concepts of depth, perspective and scale were communicated through their drawings. The importance of the environment is clear, for both children had enjoyed a rich pictorial background where the reading of pictures had been taught; both had travelled in an aeroplane and so grasped the concept of 'bird's eye view' (Wilmot 1994). Bruner's ideas are of further significance because of the emphasis placed on the role of instruction in the process of concept development. Whereas the teaching strategy based on Piagetian theory could be termed 'passive' in that it moulds itself around the thought processes of the child, Bruner's is active in that it endeavours to speed up the process of concept formation. Bruner's view that concepts need to be revisited by children a few times as they progress through school has led to the adoption of a spiral curriculum in which the central concepts are introduced at an early age and re-visited at increasing levels of complexity and sophistication as the child matures (Bruner 1971; Hall 1976).

Both theories view the individual as actively constructing meaning out of experience, and both suggest a developmental sequence in concept development. Whereas Piaget views cognitive development as dependent on innate capacities which unfold with biological maturity, Bruner sees cognitive development in broader culturally transmitted terms. For Bruner the heart of the education process lies in providing "aids and dialogue for translating experience into more powerful systems of notation and ordering", and that for this reason it is "necessary to link a theory of development with both a theory of knowledge and a theory of instruction" (Bruner, as quoted in Hall 1976: 241).

Vygotsky's view represents a radical departure from that of Piaget's. Whereas the latter recognised the effects of both social environment and children's development, seeing both social interaction and language as significant, he did not give them the priority that Vygotsky accords them (Knight 1993). Vygotsky places far greater emphasis on the role of communication, social interaction and instruction in determining development (Wood 1988). For Vygotsky, historical, cultural and social influences are far more important than the natural and biological. According to Vygotsky, language has the power to shape future mental development; it is not simply the product of the mind's structures but something which can itself shape them (Knight 1993). Thus certain ways of thinking are not simply natural products of the mind or the sole creation of children. Rather these are seen as cultural interventions that have to be learned through social interaction with those who already possess and practise them (Wood 1988). Children who are unable to perform tasks and solve problems on their own, often succeed when helped by an adult. Vygotsky postulated that the capacity to learn through instruction is itself a fundamental feature of human intelligence. Further, when adults help children to accomplish that which they are unable to do alone, they are fostering the development of knowledge and ability. Teaching and instruction are seen as the heart of development. Social interaction is seen as the prime way in which children learn, with co-operatively achieved success being the foundation of development and learning.

This study does not seek to discredit or disprove any one of the views of development described above. Rather, the results of the various tasks used in this study to illuminate and describe children's spatial perceptual and spatial conceptual capacities, will be evaluated in

the light of what is suggested by the various perspectives. The next step is to proceed to an analysis of various theories of learning, in order to understand links between these and the theories of development discussed above.

2.5.4. Learning theories

Prawat (1992) claims that current conversations about the nature of teaching and learning differ dramatically from those of 20-30 years ago. Traditional views of knowledge based on a reality out there and in terms of which the acquisition of knowledge involved simply finding a match between what we know and reality, have been criticised. The belief that something is true if and only if it corresponds to an independent, objective reality has been held up for scrutiny.

Cognitive psychologists, building on Piaget's ideas, have drawn our attention away from the traditional view of the mind as a 'black box' where we can accurately judge what goes in (stimulus) and what comes out (response), but about the workings of which we have little, if any idea, to a concern about what happens within the 'black box'. The environment has come to be viewed as the black box - with each of us knowing what is going on in our minds. What we can only guess about is the relationship between our mental structures and the real world. Cognitive psychologists have emphasised that

> All children bring a wealth of knowledge with them into the classroom. They are not, as it was previously thought, 'sponges' soaking up knowledge according to their ability levels. They have definite views about what is taught. Like adults they develop theories about nearly everything.... Children use theories to frame their interpretation of new information. Because these theories help them to make sense of their world, children are often hesitant to change them.
>
> (Prawat 1992: 11)

Further, it is observed that

> Current research... also focuses on the role of the student. It recognises that students do not merely passively receive or copy input from the teachers, but instead actively mediate it by trying to make sense of it and to relate it to what they already know (or think they know) about the topic. Thus, students develop new knowledge through a process of active construction. In order to get beyond rote memorization to achieve a true understanding, they need to develop and integrate a network of associations linking new input to pre-existing knowledge and beliefs anchored in concrete experience.
>
> (Brophy 1992: 5)

The roots of constructivism can be traced back to the work of Piaget. His research, based on observations of how children learn and acquire knowledge, showed that individual learners construct their own meaning. Knowledge is actively constructed in the mind of the learner, and coming to know is a process of organising and adapting to the world as experienced by the learner (Gadanidis 1994). Whereas the traditional view looks for a match between knowledge and reality, the constructivists see the construction of knowledge as a search for a fit rather than a match with reality (Bodner 1986).

Radical constructivism sees this construction of meaning as something that every individual does on his/her own. As each individual is confronted with some stimulus, he/she will turn to experience and prior knowledge and will try to find regulation and order to construct meaning or make sense. Thus the way one comes to know is to fit together what one already knows with what one needs to know or with new learning. Piaget stressed that knowledge is

> ... acquired as the result of a life-long constructive process in which we try to organise, structure and restructure our experiences in the light of existing schemes of thought, and thereby gradually modify and expand these schemes.
>
> (Piaget, as quoted in Bodner 1986: 874)

The individualistic emphasis of radical constructivism leads to some significant weaknesses, namely that

- its cognising subject appears to be near hermetically sealed in a privately constructed experiential world of its own;
- its representations of the world and indeed of other human beings are personal and idiosyncratic;

- the secondary role accorded to the realm of the social and other persons is a serious weakness for education if it is to get beyond the individual learner to interpersonal relations, and the social context of schooling;
- it can lead to an overly child-centred, romantic progressivism. Constructivism conceived in a loose and emotive way, can become associated with a sentimental view of the child... an overshielding of the child from social influence, from the 'nasty' realities of the world. This romanticism, as part of the progressive teaching ideology, sanctions anything the child does as expressions of its individual creativity, and naively assumes that the child can discover much of conventional school knowledge on its own.

(adapted from Ernest 1993)

Social constructivism emphasises language, culture and social milieu and so compensates for these omissions in radical constructivism. Clements and Battista (as cited in Klein and Marriot 1994: 15) list five tenets of constructivism, namely that

- knowledge is actively constructed by the child, not passively received from the environment;
- children create new knowledge by reflecting on their physical and mental actions;
- ideas are constructed or made meaningful when children integrate them into their existing structures of knowledge. No one true reality exists, only individual interpretations of the world. These interpretations are shaped by experiences and social interactions;
- learning is a social process in which children grow into the intellectual life of those around them, and
- when a teacher demands a learner use set mathematical standards, the sense-making activity is seriously curtailed.

Constructivism thus emphasises the importance of a child's prior experiences and of his/her cultural background and environment for the learning process. Cognitive psychologists have identified 'the former experience' as the most important predictor of a child's conceptual understanding. Anthropologists and cultural psychologists also emphasise that context plays a key role in shaping and constraining individual learning (Prawat 1992: 11).

> What kinds and amounts of knowledge one has before encountering a given topic in a discipline affect how one constructs meaning. The impact of prior knowledge is not a matter of 'readiness', component skills or exhaustiveness; it is an issue of depth, connectedness, and access. It includes all kinds of knowledge... and is the source of both conceptions and misconceptions.... Knowledge is a complex network of ideas, facts, principles, actions and scenes: therefore prior knowledge is more than a building block of information. It can facilitate, inhibit or transform a learning task. (Leinhardt 1992: 22)

The primacy of the teacher in the learning process is stressed. Teachers need to help their pupils to build up from existing knowledge by providing the necessary support, or in Bruner's terms, the 'scaffolding' on which pupils can expand their understanding. The teacher needs to recognise and accept that each child enters the classroom with prior knowledge based on his/her experiences and not as an empty vessel in need of filling with knowledge that the expert (teacher) has and that she/he will transmit to the child.

Vygotsky's ideas are of significance for constructivism because of the emphasis that he places on language. From early childhood, children use language to communicate their ideas to others and they use it to 'talk to themselves.' This silent tool for thought is very important for it acts as a mediator between thought and action. Inner-directed language forms the basic structure of thinking. Language is essential to development and it is acquired through interactions with others (Bruner 1986). The implications for the acquisition of graphic skills are significant in South African primary schools where children have the choice of eleven official languages as the medium of instruction. Many of the spatial perceptual concepts do not translate into other languages and it is to be expected that language, in some instances, will complicate the acquisition of these skills. Langhan's research (1993) shows the difficulties that second language learners experience with text books. The current South African language policy may well exacerbate the problems of learning in primary schools.

Constructivist theories of learning are significant to graphicacy for they recognise the importance of teaching, of an explicit pedagogy, as opposed to the traditional model of transmission which relies heavily on rote learning and factual recall. The later is still dominant in many South African schools where children are encouraged to rote learn the pictures in their textbooks (Langhan 1993: 3). Adopting a constructivist approach has enormous implications for teachers and teaching methodologies in the context of graphicacy.

2.5.5. The need to teach graphicacy skills

Graphicacy is a basic skill which develops in children alongside literacy and numeracy (Boardman, 1976); it must be taught, and it must be taught from the day a child enters

formal school. Reasons for this include:

- the primary school must bridge the gap between what the brain can do for itself and what has to be learned explicitly (Balchin 1972: 1996);
- graphicacy, like literacy and numeracy, is composed of a number of procedures which need to be taught (Balchin and Coleman 1965);
- the full extent of graphicacy is more complex than that of literacy and numeracy, for the media used are more varied with different colours, textures, balance and pattern which need to be considered (Robinson, in Balchin and Coleman 1965; Balchin 1996);
- young children come to school enthusiastic and curious to learn. When confronted with new experiences, they do not view these as threatening or exhibit the fear that adults often do. The complexity and sophistication of graphicacy is such that it can be off-putting and incomprehensible to ingraphicate adults; if taught early while the child is still in the skill-learning stage, then a basic confidence can be acquired (Balchin 1996);
- in the context of the multicultural classroom, there is a need to ensure that all children acquire the skills necessary to read and interpret graphic representations which they may not have been exposed to at home or which they make sense of differently. The school has an obligation to ensure that all children will succeed and are able to access the information communicated to them in all possible ways (Fulgesang 1982; Lanham 1990);
- graphic material is more pervasive in all spheres of life than ever before. Children are bombarded with visual material at increasingly sophisticated levels and in all subject areas. If we wish to give children additional powers to operate in the modern world, we need to teach graphicacy skills as early as possible (Fry 1981; Gillespie 1993; Glasgow 1994; Boltt & van Harmelen 1995);
- a variety of graphic representations including pictures, photographs, diagrams, graphs, cartoons, maps, are included in the text books of many subjects in the senior primary phase. These are used in different ways and for different purposes. They need to be read and interpreted by the child if they are to aid learning. A child needs to be introduced to the procedures necessary to do so **before** having to do so. In this way the learning activity can remain fun and non-threatening.

2.5.6. Graphicacy as a neglected / misunderstood 'ace'

Fry (1981) maintains that isolated elements of graphicacy teaching exist in many schools but that as a concept it is not well developed or understood. My personal experience with primary school teachers and with student teachers supports the view put forward by Fry (1981). Almost all of the primary teachers and students teachers with whom I conversed indicated that they were unfamiliar with the term graphicacy and that they knew nothing about it. However, they indicated that they used pictures, posters, diagrams, cartoons, maps and photographs in many of their lessons. From this one may infer that no conscious, structured or explicit teaching of graphicacy takes place. Graphic representations are used but it appears that children are assumed to acquire the skills to read and interpret them naturally as they mature. This is in line with the Piaget's developmental theories and with his emphasis on the lonely learner.

If we are to teach graphicacy in the primary school, the question of who will do it and to what extent they are equipped to do so, demands serious consideration. Most primary school teachers are, by virtue of primary teacher education programmes, generalists rather than subject specialists. Many have not studied geography after school. It should not be assumed that primary teachers have an adequate conceptual understanding of or the skills associated with graphicacy. The implications for teacher education programmes are enormous. The curriculum design of both pre-service and in-service teacher education courses needs to be evaluated if ways of developing the capacity to teach graphicacy are to be sought.

If it is accepted that graphicacy is a basic skill and that it is by nature interdisciplinary, then all teachers in the primary school need to understand and value graphicacy and all should teach it. Graphicacy, as a form of communication, is associated specifically with geography because of the importance the subject attaches to the teaching of maps and photographs. To teach graphicacy only in geography and to assume that the skills will transfer to other subjects, is problematic. Graphic representations relate to subject-specific concepts, and as such they need to be taught in context because graphicacy has as much to do with cognition as it has to do with spatial perception.

2.6. PICTURES AS GRAPHIC REPRESENTATIONS

2.6.1. The importance of pictures and the need to teach them

Amongst graphic representations, pictures and photographs are an important means of communicating spatial information and the meaningful study of them is dependent on the child's perceptual ability and his/her conceptual understanding (Boardman 1983). Pictures, be they photographs, simple line drawings or any other form, are the most common graphic representation used in the junior primary school. They offer the most concrete representation of reality in two dimensions. Pictures are particularly useful for introducing and developing the graphicacy skills which underpin interpretation of the more complex graphic documents such as maps which the children will encounter at a later stage in their primary school career. Despite their relative simplicity, pictures and photographs, like maps, present numerous perceptual and conceptual problems for children (Boardman 1983). Research has shown that children in the secondary school experience difficulty with mapwork because of spatial perception problems (Burton 1986; Ndlwana 1991; Schurmann 1992).

Many authors stress the importance of teaching children to read and understand pictures (Garnett 1960; Gopsill 1962; Barnard & Nel 1973; Mangan 1978; Fuglesang 1982; Robinson 1986; Benjamin 1989; Wright 1989; Lanham 1990; McFarlane 1992; Bisplinghoff 1994; Couch, Caropreso & Miller 1994; Fredette 1994; Scoffham & Jewson 1994; Boltt & van Harmelen 1995; Walters, Quinn & Wilmot 1995; Griffiths-Myers 1997). Reasons cited for this include:

- methods of reading pictures have to be learnt, in the way that one learns to read pages of a book (Lanham 1990);
- conventions and cues associated with pictures are culturally specific and as such need to be taught. It cannot be assumed that all children will know or understand these, no generalisations can be made, no universals exist. The conventions need to be learnt (Mangan 1978; Griffiths-Myers 1997);
- when one considers the cognitive processes involved in reading and interpreting a

picture, one begins to appreciate that pictures as a form of communication are as complex as any written text (Boltt & van Harmelen 1995);

- many children have difficulty in understanding the relationships and significance of what is shown in pictures (Benjamin 1989);
- it cannot be assumed that children will interpret pictures in the same way as the teacher nor that they will benefit or learn from what sense they make of them (Wilmot 1996a);
- it cannot be assumed that pictures will enhance the learning process. They may confuse the child instead (Wilmot 1996a);
- it cannot be assumed that if a teacher explains a picture to a child, that knowledge will be transferred and that learning will take place. Rote learning a picture is ineffective because the skills specific to graphicacy will not have been acquired and so the child will not possess or be able to apply a strategy for learning another picture (Boltt & van Harmelen 1995).

Whilst numerous pleas have been made for the teaching of pictures (the decoding aspect of graphicacy), far less has been said about the teaching of the encoding aspect of graphicacy, drawing or picture composition. Clearly, there is a need both to teach children how to read and interpret the pictures of others and to help them to create, read and interpret their own representations of reality. Balchin (1972) observes that upon entering primary school, children recognise the defects in their own pictures which are often associated with a lack of perspective. This is the appropriate time to introduce the concepts of size, shape, direction, symbols, angular measurements, colour distinctions and types of patterns, all of which are foundational for later development through exposure to more complicated concepts in graphicacy. The primary school has an important role to play in bridging the gap between what the child can do for itself and what needs to be explicitly taught and learned.

Warwick (1987) and Boltt & van Harmelen (1995) observe that although pictures are the oldest form of visual communication, they are perhaps the least researched and understood. Little has been done to establish how children process the information contained in pictures, what skills they need to do so and how they acquire these. Despite this, pictures and other graphic representations are being used more than ever before in text books, in computer

programmes and as teaching aids. The level of sophistication has increased in recent years. Children need to be taught the spatial perceptual skills associated with pictures at an early age so that they can use pictures and create pictures to communicate effectively in the world.

2.6.2. Making sense of pictures

2.6.2.1. The skills required to make sense of pictures

Making sense of pictures is a two-fold process. Firstly, it involves reading a picture in a literal sense; secondly, it involves interpreting what one has read. Wright (1989) claims that the following four reading skills need to be utilised when reading a picture:

- skimming for gist;
- scanning to obtain certain information;
- extensive reading skills where the reader deals with the text as a whole. This requires understanding of the component parts and their contribution to the overall meaning of the picture; and
- micro-skills such as predicting. This requires using one's knowledge and understanding of the circumstances to make predictions about what is seen. It also implies recognising implied meaning.

Decoding information contained in pictures requires the utilisation of the spatial perceptual and spatial conceptual skills associated with graphicacy. Van Harmelen & Boltt (1995) identify these as:

- the ability to observe objects and relate them to 'reality'
- understanding 2-D representations of 3-D objects in the 'real world'
- the ability to make sense of unfamiliar objects represented in 2-D in order to connect them to 3-D
- making sense of shape alterations in schemata representations
- understanding depth perspective

- being able to juxtapose objects using familiar 'views' i.e. above/below and front/side
- having developed an understanding of the many conventions used in visuals
- understanding scale
- understanding direction
- understanding proportion/ratio
- understanding shape, colour and size representations and relationships
- understanding pattern
- understanding specific concepts embedded in the visual

Interpreting and making sense of a picture require the utilisation of all the skills listed above, skills which enable children to 'read between the lines' and thus gain information about that which is implied but not necessarily obvious. According to Wood (1988: 69) interpretation requires children "to infer solidity and depth from cues like the relative size of different objects in the picture or from differences in texture, perspective cues, overlap of parts of the objects by another and so forth." He stresses that perception of such things is neither natural nor automatic. Children have to be taught the conventions governing the interpretation of pictures and while this is usually done informally in the home, it should not be assumed to be the case for all children. Interpreting pictures also requires children to deduce relationships shown, to express opinions and speculate about who, what, where and why the picture shows what it does. Children thus need to synthesise and integrate the various 'bits' of information which they have read in the picture in order to gain understanding of what has been communicated in the picture. In other words, they need to see and understand the various components of the picture holistically. Wood (1988) claims that the early years of schooling have an important role to play in teaching children how to attend to and interpret their world in the same way as the mature members of their culture.

According to Clay (1991) we should not underestimate the importance of early childhood experiences in the process of learning to read. The eyes have to search a picture, picking up information which the brain has to interpret. This needs to be taught and practised. Children who arrive at school having not had opportunities to learn the skill of attending to visual detail (by scanning, analysing and organising shapes, patterns, letters, relationships) may not have the skills necessary for good progress in reading. Clay (1991) stresses the

need for children to have an adequate range of experiences in early childhood, both in the home and in the pre-school. These include learning to attend to pictures in books as well as exploration and play in the environment.

Proponents of the visual literacy movement (Mangan 1978; Couch, Caropreso & Miller 1994; Fredette 1994; Griffiths-Myers 1997) stress the need to teach children the conventions of pictorial representation, but they approach the matter largely from a technical point of view, focusing, for example, on how to identify the cues which indicate scale. The weakness of this approach is that it assumes that, having been taught the technical skills of reading pictures, children will be able to make meaningful sense of pictures. What appears to be overlooked is the need to teach spatial concepts as well: in the example cited, the recognition of scale becomes meaningful for the child only if he or she has an understanding of the concept of scale.

Guided by the ideas outlined above, it is argued that reading a picture is underpinned by a complex network of interrelated and interdependent skills. These include:

- spatial conceptual skills including the ability to recognise, discriminate, identify, analyse, judge, evaluate and synthesise information contained in a picture;
- spatial perceptual skills, including the ability to recognise colour, shape, size, pattern/detail, perspective, scale, figure-ground organisation, spatial relationships;
- reading skills, including the ability to skim the picture or 'read for gist'; scanning for specific information; comprehending what has been read; and
- language and communication skills, namely, the ability to use appropriate language to describe and express what has been read with clarity and accuracy in the spoken or written modes of communication.

2.6.2.2. Factors influencing the acquisition of skills

Despite the Piagetian belief that spatial perception and hence the acquisition of graphicacy is sequential and dependent on maturation, there is evidence from research that this is not the case. Van Harmelen & Boltt's research (1995) shows that culture plays a significant

role in the acquisition of spatial perception ability. In-service primary school teachers were found to be deficient in spatial perceptual and spatial conceptual skills, experiencing considerable difficulty in completing tasks which required these skills.

Mangan (1978) claims that culture is a significant factor. People will fail to see things outside their cultural experience or will interpret them in terms of their own cultural experience. For this reason one cannot assume that everyone will see the same thing when presented with the same picture. Different cultures have different ways of depiction. Different conventions are used which have to be learned. For instance, a child from one culture may not be familiar with the way in which depth is shown by another culture. This needs to be taught. The implications for the multi-cultural South African primary school are enormous.

Fuglesang (1982) claims that people need to learn to read a picture as they do a book. Pictures, like language, have their own syntax of visual cues. The reading of pictures is largely an informal process and those living within a social environment with little or no picture tradition, do not experience the informal process of picture education. Langhan (1993) found that Std 3 English Second Language pupils had difficulty reading the illustrations in geography text books. Children from homes where there is limited access to books or where books are not valued, are not likely to have been taught how to make sense of pictures. Even in homes where books are available, there is no guarantee that children will have been read to and taught how to read pictures. In many South African homes, both parents are breadwinners who are away from home for most of the day and have little time to read to their children. Contemporary lifestyles and preferences may also have a negative impact on children's reading habits: most children with access to television spend more time watching TV than reading.

2.6.3. The use of pictures in the primary school

Pictures and photographs are frequently used in the primary school for a number of purposes. A survey conducted in Australian schools (Fredette 1994) revealed that pictures were used mostly by teachers for display purposes, followed by motivation (to stimulate

incidental learning); to illustrate key points; to elaborate and supplement verbal texts, and - least frequently - as a main source of information. From this one may infer that the educational potential of the extended use of pictures had not been realised

Observations made by primary school student teachers during their May 1996 teaching practice revealed that pictures are used most frequently for decorative purposes, and that they were seldom referred to or related to the subject matter being taught. Further, it was reported that pictures drawn by the children were displayed but seldom referred to, nor were the children required to explain the sense that they made of their pictures (Wilmot 1996b). The student teachers observed that many children had difficulty making sense of the pictures in their text books.

Pictures are used in young children's books to lighten the text and to illustrate or explain or elaborate on the written text. Whilst one would expect pictures to enhance the learning process, research conducted with a 10 year old revealed that the pictures in the reading book did not correspond with the explanation provided by the written text, and were therefore a source of confusion. With adult help and accurate but more sophisticated and abstract pictures and diagrams, which the child was taught to make meaning of, the written text in the reading book was enhanced (Wilmot 1996a).

2.7. CONCLUSION

This chapter has revealed that all children need to develop a sense of identity with and in their environment. Formal education, as a process with life-long implications, has an important role to play in fostering this development within a framework of place, space and time. This, it is argued, is necessary for sustaining life on this planet and for our survival as a species. Further, as social beings individuals need to communicate with each other through four modes of communication. Graphicacy is the mode of communication through which spatial information about the environment is most frequently conveyed. Graphicacy is a complex form of communication which utilises symbols other than words or numbers to convey spatial information. It is underpinned by a complex and interconnected network of spatial perceptual and spatial conceptual skills. If graphicacy is accepted as an essential

mode of communication and therefore a vital element in education, then the skills and concepts associated with it must be taught, and this needs to be done as early as possible within the formal school system. Teaching graphicacy implies that the skills requisite for its acquisition need to be identified and understood. Further, the assimilation of these must be viewed against the backdrop of how children are seen to develop and learn.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. INTRODUCTION

The aim of this research is to investigate and seek understanding of graphicacy as a form of communication in the primary school. More specifically, the study seeks to investigate the sense that children make of pictures, the form of graphic representation most frequently encountered by young children.

The research was conducted in two stages. The first stage comprised two diagnostic activities, the purpose of which was to identify and describe the spatial perceptual and spatial conceptual skills which children utilise and apply when both encoding information in graphic form and when reading and making sense of pictures. The second stage comprised interviews with a sample group, the purpose of which was to investigate more fully the responses made to the diagnostic activities, and to illuminate and describe factors which may have impeded or enhanced the children's interpretive activities.

This chapter describes and explains the research procedures followed in the study. More specifically, it deals with the following:

- the paradigm in which the research is located and its influence on the research methodology;
- the case study as a research method;
- selection and characteristics of the participants;
- research ethics;
- data collection and analysis;
- design of the research instruments; and
- triangulation.

3.2. THE PARADIGM AND ITS INFLUENCE ON THE RESEARCH METHODOLOGY

This section offers an overview of the paradigm chosen for the study as well as a critical evaluation of its perceived strengths and weaknesses. This study may best be described as a qualitative one which falls within the interpretive or descriptive paradigm (Lincoln & Guba 1985; Cohen & Manion 1989; Denzin & Lincoln 1994; Stake 1995). Key characteristics of the interpretive paradigm are shown in Table 3.1.

- To understand the subjective world of human experience; that is, to seek understanding of complex interrelationships which exist therein, as opposed to explaining or controlling them.
- Knowledge is seen as constructed rather than discovered. Interpretive researchers thus start with individuals, and seek to understand their interpretations of the world around them.
- Interpretive research is not theory driven. Theory is emergent; it develops from experience, from understanding the actions of individuals within specific contexts and situations.
- The uniqueness of individual cases and contexts is seen as important. Understanding the particular is favoured above a search for the development of universal theories and generalisations.
- The focus is on action, more specifically on observing, describing and interpreting action 'as it is' within the context in which it occurs.
- In order to understand the subjective world of human experience, the interpretive researcher becomes involved and participates in the research. The ongoing, interpretative role of the researcher is viewed as central to inquiry.
- Data is gathered in the field using methods of direct observation, including participant observation and in-depth interviews.
- Qualitative research uses both quantitative and qualitative approaches to data analysis. The latter approach is seen as preferable because it is better suited to the purpose of describing and interpreting.
- Research questions focus on cases or phenomena and are typically questions which seek patterns of unanticipated as well as anticipated relationships.
- The research design is sufficiently flexible to allow for redirected observation and the perusal of emerging issues.

Table 3.1. Summary of the key features of the interpretive paradigm

Of the key dimensions of the interpretive paradigm, as summarised in Table 3.1., the following emerge as relevant to this study:

- the research is concerned with understanding the subjective world of human experience, as opposed to explaining or controlling;
- the focus is on action, more specifically on observing, describing and interpreting action 'as it is' within the context in which it occurs;
- the uniqueness of individual cases and contexts is seen as important and is valued above a search for universal theories and generalisations;
- data is gathered in the field using a variety of methods, all of which require the direct involvement and participation of the researcher, but which may also include observations made by non-participant observers; and
- multiple voices are encouraged.

These key dimensions justified my choice of paradigm for the study for a number of reasons. Ironically, these same key dimensions are the ones which have been most strongly questioned by critics of the interpretive paradigm. Yet, it was these perceived weaknesses which to a large extent made this paradigm so attractive to me in terms of what I was wanting to do. The strengths and weaknesses of the interpretive paradigm will now be discussed, together with the ways in which the study attempted, as far as possible, to avoid some of these perceived problems.

The purpose of the study was to seek understanding, to explore and develop propositions for further enquiry through answering 'what' and 'how' type questions which according to Yin (1989: 19), is associated with interpretive research. The study is not concerned with measuring ('how much' or 'how many' type questions), nor does it seek to examine a cause-effect relationship between two or more phenomena (Dane 1990: 7), questions associated with research within alternate paradigms. Rather, this study is concerned with meaning or interpretation in relation to one form of communication, namely graphicacy, as it occurs within a specific context. The interpretive paradigm was seen as appropriate because this study is not concerned with identifying causes, but seeks to illuminate actions and constructs and to find meaning. Researchers working within an interpretive paradigm accept that the findings of their research are tentative rather than assertive, serving to stimulate further inquiry rather than to provide answers.

The study is concerned with exploring and describing a particular phenomenon of education 'as it is.' The aim of the study is to understand the sense that a group of children made of pictures as well as the skills they utilised in order to do so. This required engaging with the children, watching and listening to them, observing and interpreting the sense that they made of pictures, and identifying the skills which they employed in order to do so. This study is an empirical one in that it relies on direct observation of a specific case in its natural setting, rather than in a contrived or laboratory type setting, and as such it is suited to the interpretive paradigm.

According to Maykut & Morehouse (1994: 174) the purpose of qualitative research is to "accumulate sufficient knowledge to lead to understanding." This study has attempted to do this by obtaining data from multiple sources and as interpreted by multiple voices, namely the participant observer and non-participant observers. The role and organisation of the latter is addressed in Section 3.5.3.

Data collecting techniques used were based on what Lincoln & Guba (1985) refer to as 'human instrument' and field methods based on direct observation, the most important ones being participant observation, field notes made by non-participant observers and interviews. Data was analysed using both quantitative and qualitative approaches. Quantitative approaches were seen as appropriate for they allowed for numerical comparison and were useful for identifying trends and patterns, suggesting what was going on within the class as a whole; qualitative approaches were seen as appropriate for exploring in more detail what had emerged from the quantitative analysis (Swann 1994). Theory was used to focus the inquiry, not to drive it, to give the study boundaries for comparison in facilitating the development of theoretical outcomes. The relevant theory "may be considered a conceptual template with which to compare and contrast results, rather than [a set of] a priori categories into which to force the analysis" (Morse 1994: 221).

Research located within the interpretive paradigm accepts that the research findings emphasise subjective interpretation which, in reflecting the particular perceptions of participants, may be biased. Subjectivity is recognised and valued as an essential element of understanding, and triangulation, as a means to overcome investigator bias, is applied.

Recognising this as a key dimension of this paradigm, I tried to be mindful of my own subjectivity and conscious of my position in the research. Attempts to overcome possible problems which could arise were made through the application of rigorous procedures to validate the subjective data. Triangulation using data obtained from multiple sources for cross-checking purposes and multiple data collecting techniques were employed. The data was also interpreted by multiple voices, namely those of the investigator as participant observer and the non-participant observers. These two dimensions are discussed in more detail in Sections 3.6. and 3.8.

It is accepted that interpretive studies, as personalised studies, carry substantial ethical risks. A conscious effort was made to address these. As the study is a highly personalised one which involved children, serious consideration was given to ethical questions. This is discussed more fully in Section 3.5.

3.3. THE CASE STUDY AS A RESEARCH METHOD

Case studies, as a research method, can fall into a number of different paradigms. Table 3.2. shows the use which this study, located within the interpretive paradigm, made of the case study.

The particular case study method selected for this study was seen as appropriate for two reasons. Firstly, this study was to be a small-scale investigation into graphicacy which sought to understand the phenomenon. It was to explore and describe the phenomenon as it occurred within a specific, bounded and unique case. The case on which this study focused was a Standard 3 class consisting of 17 boys. The investigation focused firstly on the class, as a unit or bounded case, and secondly, on certain individuals as sub-cases embedded within it. By focusing on the class as a single unit, existing patterns and trends could be identified and described. Guided by the patterns and trends that emerged from the class, a purposive sample was selected for further investigation.

- A 'case' is viewed as a phenomenon of some sort occurring in a 'bounded context', namely that of the unit of analysis (Denzin & Lincoln 1994: 440).
- "Case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstance" (Stake 1995: xi).
- Case study research differs from experiments and surveys in that the researcher does not manipulate variables to determine causal significance or ask standardised questions of a large, representative sample of any population, rather it is a research approach in which observation of the characteristics of an individual unit, be it an individual, class or school, is central (Cohen & Manion 1989).
- Case study method focuses on understanding the particular within a specific context; it utilises a variety of data collecting techniques, most important of which is observation (Stake 1995).
- It is well suited to rich interpretation and thorough understanding, the goal of which is to understand the case rather than to seek to establish generalisations about the wider population to which the unit belongs (Stake 1995).
- Case study research is concerned with "the portrayal of the idiosyncratic and the particular as legitimate in themselves" (Walker 1993: 163).
- The case study researcher admits the "fragility" of their interpretation and that the recommendations based on the results of the research, should be viewed as tentative and provisional (Walker 1993: 174).

Table 3.2. The case study research method as used in this study

This study has boundaries which determine what is 'inside the case'. In the terminology of Hitchcock & Hughes (1995: 319), the 'key players' consist of the 17 children in the class; the 'key situations' in the life of this case consist of three encounters that I had with the children. Through these 'critical incidents' I try to throw light on what was happening and how it was happening in the life of the case (Hitchcock & Hughes 1995: 319).

Secondly, this study is best described as a small-scale, interpretive case study. It is interpretive in that in describing what is, it "seeks to open out an educational situation to intelligent criticism and appraisal" (Hamilton 1976: 39). It seeks to explore and describe the spatial skills underpinning graphicacy as a form of communication as these are practised in a single South African primary school classroom. It then seeks to evaluate what emerges from the study in the light of current theory about graphicacy. In seeking to provide understanding, this research should help the reader to acquire a more informed view of the acquisition of graphic skills and whether or not there may be a need to teach them in the foundational stage of formal education.

Qualitative case studies are criticised because they lack rigour (Yin 1989); they also take time and effort and can result in huge amounts of data being collected which is difficult to analyse and interpret and because it provides a poor basis for generalisation (Stake 1995). Alerted to these perceived dangers, I attempted to address them in a number of ways.

According to Yin (1989) the problem of possible lack of rigour can be overcome through thorough and systematic planning of the research design. This, he explains, necessitates that data collected in each stage of the study be analysed immediately thereafter, in order to establish what needs to be explored in more detail during the following stage of the research, and with whom this should be done. Following Yin's recommendations, a research design model was developed using Parlett and Hamilton's three stages of research (in Stake 1995: 22). The three stages are described as:

- investigator observes;
- inquires further; and then
- seeks to explain.

Further the research design incorporated the concept of "progressive focusing" which is described as follows:

> Obviously the three stages overlap and are functionally interrelated. The transition from stage to stage, as the investigation unfolds, occurs as the problem areas become progressively clarified and re-defined. The course of the study cannot be charted in advance. Beginning with an extensive data base, the researchers systematically reduce the breadth of their enquiry to give more concentrated attention to the emerging issues.
>
> (Parlett & Hamilton, in Stake 1995: 22)

Fig. 3.1. shows the model of research design used in this study. It reveals the purpose and focus of each stage of the study and how these change as one moves from one stage to the next. It also reveals how I was dependent on what emerged from Stage One before I could select a purposive sample with whom to proceed in Stage Two of the study. Fig.3.1. shows the different data collecting techniques used in each stage.

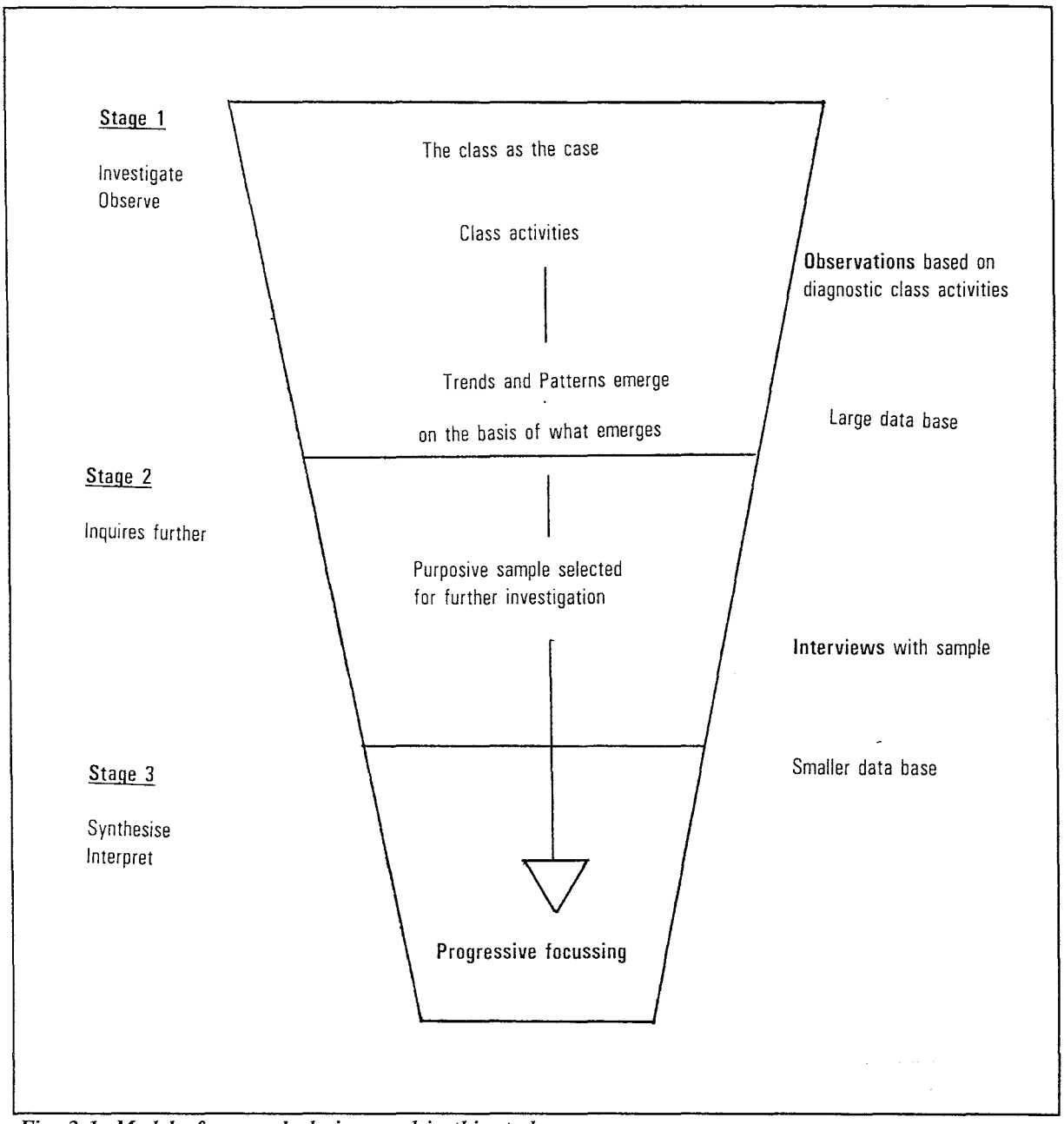

Fig. 3.1. Model of research design used in this study

Data obtained during each of the stages was analysed before the next stage of the study commenced. In this way, the problem of having to cope with an unwieldy amount of data for analysis on completion of the data collecting, was overcome. Collating the data obtained from different sources was nevertheless time-consuming and complex.

The design of the study as shown in Fig. 3.1. helped to keep me focused throughout the various stages of the research. It was extremely useful because it provided a frame for what

was being done and why it was being done, without dictating what was to be expected or what should emerge from each stage. Qualitative research employs inductive rather than deductive analysis in that "categories, themes and patterns come from the data" (Janesick 1994: 215), which makes it impossible to know in advance what might emerge or from what source it might emerge. The research design therefore needs to be flexible enough to accommodate the 'emerging.' Thus whilst I was aware of the need for rigour in case study research and hoped to achieve this through thorough and systematic planning, so too I was aware of a tension existing between this and the need to ensure that the design was also flexible enough to accommodate what 'emerged' during the data collecting.

Despite qualitative case studies being attacked for yielding unmanageable quantities of data for analysis which may leave the researcher drowning in a sea of confusion, Morse (1994: 229) claims that "out of confusion, order and understanding *emerge.*" However, he continues, this does not occur without considerable effort, time, determination, persistence and perseverance. The danger of unmanageable amounts of data was addressed by choosing, firstly, a case which was of a manageable size (17 boys), and secondly, a small purposive sample consisting of four boys for in-depth investigation. The study also limited its focus to only one type of graphic representation, namely pictures. Further, the data collecting was planned in such a way as to avoid spending an excessive amount of time in the field. Two contact sessions were spent with the class and one further contact session was spent interviewing the sample.

Stake's (1995) contention that case studies provide a poor basis for generalisation, was not considered a limitation. As a case study located within the interpretive paradigm, this study has as its goal understanding of the particular rather than a search for generalisations.

3.4. SELECTION AND CHARACTERISTICS OF THE PARTICIPANTS

3.4.1. The choice of case and of sub-cases

Standard 3 was chosen as the case for this study for the following reasons:

- graphicacy is a form of communication through which spatial information about the environment is most frequently communicated. Whilst geography is the subject associated with the teaching of graphic skills, notably those underpinning mapwork, graphicacy is a form of communication utilised across the curriculum. Geography is taught as a separate subject only in the senior primary stage;
- textbooks are used for the first time in all subject areas in Standard 3. Children encounter a variety of different graphic representations in textbooks of which it is often assumed they are able to make sense; and
- the junior primary phase of schooling is recognised as the skills acquisition stage in which the development of communication skills is central. These include oracy, literacy, numeracy and graphicacy. By the time a child enters Standard 3, a foundation in communication skills in general should have been laid for education in the senior primary phase to build upon.

The study initially focused on the entire Standard 3 class as a case. This enabled trends and patterns within the class to be identified and described. For this purpose, two diagnostic activities were conducted with the class. The design of the diagnostic activities is discussed in Section 3.7. The two activities formed the first stage of the research in which the "investigator observes" (Parlett & Hamilton, in Stake 1995: 22).

Secondly, the focus shifted to the subcases embedded within the case which, as the second stage of the research, was that in which one "inquires further" (Parlett & Hamilton, in Stake 1995: 22). A more detailed discussion of how the data was collected and analysed is provided in Section 3.6. Guided by the emerging trends and patterns, I chose four children as a purposive sample with whom to conduct further in-depth investigation. Section 3.6.2. deals with the selection of the sample in more detail.

According to Dane (1990), the choice of case determines the setting in which the research takes place. Setting is seen to include both the physical and social environment in which the research is conducted. Denzin & Lincoln (1994: 202) claim that qualitative research involves cases which are chosen purposively because qualitative researchers "seek out groups, setting and individuals where (and for whom) the processes being studied are most

likely to occur." The school in which this research took place was selected for a number of reasons, including:

- its proximity;
- ease of access: I was a parent and therefore familiar with the school;
- its perceived receptiveness to innovation in education and the willingness and enthusiasm of its teachers to learn from 'others' without feeling threatened or insecure;
- the organisation and management was such that problems which could delay or prevent the collection of data were unlikely to arise;
- the classes were small, thus suited to a small scale investigation and unlikely to yield unwieldy amounts of data; and
- the children were not strangers to me. This I felt was an important consideration when working with 10/11 year olds as it could help to create a relaxed and friendly atmosphere, one in which it would be possible to gain a 'thick' or rich description of events.

In selecting this school, I was aware that it was atypical of South African primary schools for a number of reasons: it was an independent school, the affordability of which was beyond the means of most South African families; it could be assumed that while many children came from affluent homes, others came from homes in which education was valued and considered worth making great financial efforts to provide; the children at the school came from diverse cultural and linguistic backgrounds. Whilst the latter may be typical of most South African primary schools, the situation in this particular case was exacerbated by the fact that some children came from other African countries and even, in one instance, from another continent. One could therefore not make assumptions about the nature of the children's early childhood experiences, other than that these would vary from individual to individual. Further, it was recognised that the children would bring different knowledge, values and experiences into the classroom.

As this study involved working with children, ethical issues demanded special consideration.

3.5. RESEARCH ETHICS

This section describes the ethical issues pertinent to this study as well as the ways in which these were addressed. It is claimed that the ethical aspects of research need to be given consideration before, during and after the research process. Dane (1990) identifies a number of ethical issues which the researcher needs to address, the following of which were important for this study: voluntary participation, informed consent, researcher's identity, anonymity of participants.

3.5.1. Researcher's identity, participation and membership in the case

Dane (1990: 46) claims that "part of a researcher's responsibility is to represent him or herself accurately." Qualitative researchers accept that research is not value- or bias-free and that the researcher early on identifies and describes his or her own biases and ideological preferences (Janesick 1994: 212). As the case selected for this study was based on convenience and access, the researcher's participation and membership in the case required clarification.

The school was one with which I, as a parent, had been associated for a period of some seven years. I had a child in the Standard 3 class selected and I was acquainted with most of the children. I was known by the parents of many of the children participating in the study, both in a personal capacity as a parent and friend, and in a professional capacity as a colleague/teacher/academic. I was aware that my relationship could affect what the children and teacher might say.

I was aware that my integrity and credibility were at stake, because of the close-knit nature of the local community. Every effort was made to be as up-front and honest as possible; to inform the children, parents and teacher as much as possible about the nature, point and methods of the research. Further, I was aware that in knowing most of the children there was a danger that my interpretations might be biased. For this reason, triangulation was viewed as particularly important. In an effort to counteract biased interpretation and in order to increase the validity of this study: data was collected from multiple sources using

a variety of techniques to do so; where possible and appropriate, non-participant observers were used, thus allowing for multiple voices, a key dimension of the interpretive paradigm, to emerge. I chose not to use my child in the purposive sample and embedded case study as I felt it would not be fair to him.

3.5.2. Voluntary participation and informed consent

> Research participants have the right to voluntary participation, the right to be aware that they are participating, and the right to information that may affect their decision to participate.
>
> (Dane 1990:59)

With due regard for the above claim, I approached the following people, all of whom were involved in the study: the headmaster, the parents, the class teacher, the Standard 3 children, and the non-participant student teacher observers.

The headmaster of the school identified as the site for the study was formally approached (Appendix 1), and written permission was obtained (Appendix 2). In providing evidence of the capacity in which I was undertaking the study, I established what Jackson (1995: 132) refers to as the "legitimacy of the project."

A letter was sent to the Standard 3 parents, informing them of the study and requesting parental consent to their child's voluntary participation (Appendix 3). In an effort to address the issue of possible psychological harm which Dane (1990) refers to as worry, embarrassment, loss of self esteem or failure, the parents were given the assurance that the purpose of the research was not to 'test' or 'measure' an individual's abilities or skills. As an additional safeguard, anonymity was guaranteed. The letter also stated that if, for any reason, a child or parent felt unhappy or uncertain during any stage of the research, the child would have the right to withdraw from the research. All but one response was positive. The parent was contacted and the matter clarified. Unfortunately this resulted in the child missing the first diagnostic 'island' activity.

The children were informed about the research by their class teacher and through the letter

to their parents. They were thus aware that I would be spending time with them collectively as a class and individually with a selected few. Before each stage of the data collecting, I explained to the children what was going to take place, what the purpose of the activity was and why I was interested in their responses. At the start of each activity, the children were told that there were no 'right' or wrong' answers, rather it was their ideas that were of interest. Further, they were told that if at any stage they felt uncomfortable about taking part, they could withdraw. At all times, the children appeared excited at the prospect of being part of this study and expressed great enthusiasm to participate. The teacher informed me of the disappointment expressed by those who had not been selected for in-depth interviews.

3.5.3. Non-participant observers' role in the study

In approaching the teacher some months before the research began, every effort was made to be completely open as regards the nature and point of the research. The teacher indicated her willingness to take part and time was spent during the school holidays discussing the study with her in detail. This included:

- re-iterating the nature and point of the research;
- explaining and negotiating her role in the study as non-participant observer who would act as a commentator, interpreter, advisor, watchdog and evaluator;
- workshopping the diagnostic 'island' activities so that she would understand the nature and point of them;
- explaining more fully the purpose of the picture reading activity and negotiating the choice of suitable pictures with her;
- explaining how trends and patterns were to be identified and how a purposive sample would be chosen; and
- explaining how non-participant student observers would be used.

Besides the teacher as non-participant observer, pre-service teachers who were members of my Geography Teaching Method class were used in the study. The latter were prepared for their role of non-participant observer by means of a workshop in which the diagnostic

activities used with the children were modelled. The purpose of so doing was two-fold: firstly, it provided the students with an experiential learning activity through which they would come to understand the nature and point of graphic skills as well as how these need to be utilised and applied when communicating through symbolic language. The workshop made them practise and reflect on and evaluate their own graphic skill development. Secondly, the workshop modelled an approach to teaching and learning graphic skills which they could use in their own teaching.

A more detailed discussion of how the non-participant observers were used in the data collection and analysis is provided in Section 3.6.1.

3.6. DATA COLLECTION AND ANALYSIS

The claim that the purpose of qualitative research is to "accumulate sufficient knowledge to lead to understanding," has methodological implications (Maykut & Morehouse 1994: 174). This study demonstrates how "sufficient knowledge" can be gathered by using multiple sources and through two or more data collecting techniques. Data was gathered in the field from multiple sources including the children, the teacher, the pre-service teachers, and the verbal and written responses and drawings of the children. Data collecting techniques included direct observation, diagnostic activities, field notes and interviews.

Following Yin's (1989) recommendation, multiple sources and techniques were also used for triangulation purposes, as a means of overcoming problems of construct validity and reliability. Denzin (as cited in Fontana & Frey 1994: 373) concurs that multi-method approaches to achieve broader and often better results, and that when a researcher uses several methods in different combinations, triangulation is possible. A more detailed discussion of triangulation follows in Section 3.8.

Multi-method approaches were particularly appropriate in this study as they allowed me to both 'see' and 'hear' the children in the process of data collecting. This covered the possibility that what the children 'say' might differ from what they 'do'. The different data collected allowed for cross-checking. This was especially necessary because, as I was

working with children with whom I was acquainted, there was a possibility that the children might try to provide responses which they perceived were 'correct' or 'desirable' or which they perceived me as wanting to hear. In Section 3.2. it was pointed out how research located within the interpretive paradigm is committed to exploring multiple and conflicting voices. Using multi-method approaches was seen as a useful way of achieving this goal (Hodder 1994: 395).

The choice of data collecting methods was guided by the type and purpose of the data required. Following Molyneux & Tolley (1987) and Catling's (1995) recommendations that graphic skills should be developed and taught through two complementary processes, as discussed in Chapter 2, two activities were used for diagnostic purposes.

These were conducted with the entire class and constituted the first stage of the research design. The nature, purpose and organisation of each activity is summarised in Figs. 3.2. and 3.3.

3.6.1. Stage One of the study: The diagnostic class activities

- **Diagnostic Activity One**

This activity was based on a number of practical drawing and mapping tasks set up in the classroom as 'islands'. A more detailed explanation of these 'island' tasks is provided in Section 3.7.1. and in Chapter 4. Working in pairs and individually, 16 children completed eight different tasks as they rotated from one 'island' to another. Fig. 3.2. reveals the spatial perceptual skills and concepts associated specifically with graphicacy which the activity sought to illuminate.

A series of eight 'island' tasks were set up. These were based on those used by van Harmelen & Boltt (1995) with in-service primary school teachers. Each 'island' task was linked to spatial perceptual and conceptual skills as summarised in Fig. 3.2.

ACTIVITY ONE

What? A DIAGNOSTIC ACTIVITY

Why?
- To identify spatial perceptual and spatial conceptual skills utilised by the class in a variety of different tasks
- To describe how children use these skills; the level of sophistication and consistency with which they do so.
- To illuminate difficulties which they experience.

How? Through a series of practical, drawing and mapping tasks.

↓

SERIES OF DIFFERENT TASKS

1. Shape sorter activity
2. Puzzle building (with picture)
3. Puzzle building (no picture)
4. Tangram construction
5. Drawing observable objects from:
   'Normal' side view
   Reversed, obscured side view
6. Drawing observable objects from aerial view
7. Drawing side view from memory
8. Drawing route map from memory

→ **requires utilisation and application of**

SPATIAL PERCEPTUAL AND SPATIAL CONCEPTUAL SKILLS

- recognising and understanding 'what' objects are in terms of
  - shape, colour, size, pattern, texture
  - discerning objects in foreground/background (figure/ground organisation)
  - discriminating between objects (similarities/differences)
- recognising and understanding 'where' objects are (spatial location) and how they are arranged (spatial distribution)
  - distance / proximity
  - depth
  - direction
- recognising and understanding spatial relationships; making sense of patterns
  - orientation
  - position of object in relation to self and in relation to other objects
- recognising & understanding perceptual constancy
- distinguishing between and drawing objects from different perspectives
- making judgements about what, where, how objects are in space

↓

from which
- patterns and trends were identified and described in terms of:
  - specific age group
  - the class as a whole
  - individuals within the class

↓

illuminate spatial skill development

↓

FINDINGS
compared and corroborated with those of Activity 2 (Picture reading)

↓

PURPOSIVE SAMPLE
selected for in depth probing

Fig.3.2. The nature, purpose and organisation of Diagnostic Activity One

Photographs and a more detailed description of the 'island' tasks are included in the Appendices (see Appendix 4). Having set these 'island' tasks up, I assumed the role of participant observer. It is claimed that a strength of participant observation is that it allows the researcher to join the group and share in the activities and thus gain deeper insights (Bless & Higson Smith 1995: 105). However, in so doing, the researcher risks losing her objectivity, for being part of an activity may pre-dispose one to become emotionally engaged. This issue was addressed through cross-checking with the observations made by the teacher and the student teachers who assumed the role of non-participant observers. Internal validity was thus increased through triangulation by multiple investigators.

Neither the teacher nor I was assigned to any particular activity. We were both able to circulate freely around the classroom and observe the children as they worked. A student teacher was placed near to each island activity, close enough to observe what took place but without getting in the children's way. The students observed how the children set about doing the tasks and recorded their observations by means of field notes.

Data collecting techniques used in this stage of the investigation had both strengths and weaknesses. The children's drawings, as the products of the activity, provided valuable empirical evidence of what this case could do and constituted the raw material for the identification of trends and patterns. The field notes made by the student teachers provided valuable insight into the process of how the children went about the activities. They acted as an *aide-memoir* for me when going through the children's work. Together, the drawings and the field notes helped me to accumulate sufficient knowledge for analysis and interpretation. I under-estimated the time and effort it would take to oversee the diagnostic activity, which prevented me from making field notes. This problem was overcome to some extent by the field notes made by the student observers.

The data was analysed according to the individual child's ability to recognise and utilise the spatial perceptual skills and spatial concepts as set out in Chapter 2 and summarised in Fig. 2.2. From the results, trends and patterns were identified and discussed on a number of levels, namely being those of:

- a specific age group (10/11 year olds);
- a specific class of children; and
- individual children.

Further, trends and patterns were identified in terms of:

- what skills and combinations of skills were utilised in each task;
- how the skills were utilised and applied;
- the level of sophistication and consistency with which skills were utilised and applied; and
- problems experienced by the children when utilising and applying skills.

The results from each task were analysed separately. The results from tasks which required similar skills were then discussed collectively. The findings were then grouped according to three levels of skill competency evident within the class as a whole, namely: an 'atypically' high level; a 'typical' level and an 'atypically' low level of skill competency.

The analysis of the route map ('island' task 8) was guided by Matthews' (1992) approach (as explained in Chapter 2.5.3.). In addition to analysing the results of each individual 'island' task and groups of similar tasks, the findings for the practical, drawing and mapping task were analysed and evaluated collectively. In this way, cross referencing was possible and recurring patterns amongst individuals were identified and described. This provided a useful framework for corroborating and comparing the findings of the Diagnostic Activity Two.

- **Diagnostic Activity Two**

Diagnostic Activity One (summarised in Fig. 3.2.) identified and described the skills which children utilised in practical tasks, through a number of drawing tasks and a mapping task. The latter tasks involved encoding and communicating spatial information about the environment using symbols. Diagnostic Activity Two was designed to illuminate how children utilised and applied the same spatial perceptual and conceptual skills when decoding

spatial information about the environment contained in eight different pictures. The activity required the children to communicate their understanding in writing.

Fig. 3.3. summarises the spatial conceptual and perceptual skills which are linked specifically to reading and interpreting pictures as a form of graphicacy. The diagram shows that in addition to identifying and describing what sense the children made of pictures and how they did this, the activity also sought to identify the children's emotional responses and attitudes to what was depicted in the pictures, as well as their awareness of and sensitivity to environmental problems. The diagram also reveals that graphic skills should not be seen in isolation from reading and language skills.

Eight colour photographs selected from National Geographic magazines were shown to the class. Copies of these have been included in the Appendices (see Appendix 5), and where applicable, in Chapter 6. The children were asked to respond to the picture in writing. The nature and point of the questions asked about the pictures are discussed in Section 3.7.1. and Chapter 5.1. The teacher's role was that of non-participant observer. Construct validity was increased through triangulation by the non-participant observer.

The empirical data obtained from this diagnostic activity was analysed using both quantitative and qualitative methods, in order to identify trends and patterns and to identify individual cases which did not conform to the 'typical' patterns which emerged. More specifically, criteria suggested by Wright (1989) were adapted for use in the study. A detailed description of the criteria is included in Chapter 5.1.

The analysis was shown to the teacher for cross-checking purposes and the selection of the purposive sample was discussed. Internal validity was increased through triangulation by multiple investigators.

ACTIVITY TWO

What? **A DIAGNOSTIC ACTIVITY**

Why?
- To identify spatial perceptual and spatial conceptual skills utilised by the class when decoding information contained in pictures.
- To describe how the class utilised these skills; the level of sophistication and consistency with which they do so.
- To illuminate the children's environmental awareness and sensitivity.

How? Through a series of picture reading tasks.

↓

SERIES OF DIFFERENT TASKS

1. Horizontal photograph
2. Horizontal photograph
3. Horizontal photograph
4. Horizontal photograph
5. High oblique photograph
6. High oblique photograph
7. Low oblique photograph
8. Satellite photograph

→ **requires utilisation and application of**

SPATIAL PERCEPTUAL AND SPATIAL CONCEPTUAL SKILLS

- recognising and understanding 'what' objects are in terms of
  - shape, colour, size, pattern, texture
  - discerning objects in foreground/background (figure/ground organisation)
  - discriminating between objects (similarities/differences)
- recognising and understanding 'where' objects are (spatial location) and how they are arranged (spatial distribution)
  - distance / proximity
  - depth
  - direction
- recognising and understanding spatial relationships; making sense of patterns
  - orientation
  - position of object in relation to self and in relation to other objects
- recognising & understanding perceptual constancy
- distinguishing between and drawing objects from different perspectives
- making judgements about what, where, how objects are in space

↓

from which
- patterns and trends were identified and described in terms of:
  - specific age group
  - the class as a whole
  - individuals within the class

↓

illuminate spatial skill development

↓

FINDINGS
compared and corroborated with those of Activity 1

↓

PURPOSIVE SAMPLE
selected for in depth probing

Fig.3.3. The nature, purpose and organisation of Diagnostic Activity Two

3.6.2. Stage Two of the study: The purposive sample

Four children were chosen as a purposive sample for further investigation. The choice of the sample was influenced by the trends and patterns which had been identified and discussed in both the diagnostic activities. Specifically, children were selected as follows: a child with a level of skill development 'typical' of the class; two children 'atypical' of the class in that their skill development was poor; one child 'atypical' of the class in that he displayed a high level of skill development.

Interviews were used as a data collecting technique to fulfil the following purposes:

- firstly, to probe, clarify and explore the child's responses to the diagnostic activities in order to understand more fully how the child made the sense that he did;
- secondly, to gain more insight into the factors which may have impeded or enhanced the sense that the child made; and
- to corroborate responses obtained from other sources.

According to Cohen & Manion (1989), the advantages of the interview as a data collecting technique are:

- it allows for direct interaction between the researcher and the primary source which allows for greater depth than do other data collecting techniques; and
- it can be used to follow up what has emerged from other methods; to validate other methods; to probe responses further.

Hopkins (1993) maintains that interviews are often a very productive source of information for verifying observations that a participant observer has already made, and he suggests that group interviews are the most productive because they are less inhibitive.

I decided that although group interviews might be more time effective and easier to conduct with children, they were inappropriate for this study. The children had already worked with

a partner and their individual responses to certain of the diagnostic activities may have been influenced by their partner. I needed to explore their personal responses in more detail and did not want these to be influenced by what others might or might not say in a group interview. I was, however, aware that interviewing the children could be problematic because, as Hopkins (1993) points out, they might:

- experience difficulty in explaining their thoughts and feelings; and
- be intimidated by the one-to-one nature of the interview, which might inhibit their responses.

I was aware that, as I was interviewing children, the following was relevant:

- the way in which I acted, questioned and responded could shape the relationship and the way in which the children responded (Clandinin & Connelly 1994);
- the kinds of questions I asked provided a frame in which the children would shape their accounts of their experience (Clandinin & Connelly 1994); and
- in interviews used for corroborative purposes, the specific questions needed to be carefully worded, so that researcher appears naive about the topic, thus allowing the child to provide a fresh commentary about it (Yin 1989).

In an attempt to meet these conditions, I decided to use informal interviews in which I raised a number of key issues in conversational style rather than having a set questionnaire (Cohen & Manion 1989). The interviews were kept as informal/conversational as possible, yet sufficiently focused to enable me to obtain the type of data that I needed.

An in-depth focused interview, as used in the study, is described as follows:

- it has the goal of understanding rather than explaining (Fontana & Frey 1994);
- it is one in which a respondent is interviewed for a short period of time - in this case 35 minutes; and
- it is appropriate when the researcher has already participated with the interviewed, and has already analysed and identified issues for further investigation. The

interview focuses on the subjective experiences of the children who have participated in the situation (Cohen & Manion 1989).

Further, a semi-structured interview was seen as appropriate to use with the children in this study for the following reasons:

- it allows the interviewer to direct the flow of ideas, to intervene and ask further questions when necessary;
- although focused, it is less formal and less rigid than a structured interview in which "a respondent is asked a series of pre-established questions with a limited set of response categories" (Fontana & Frey 1994: 361);
- in being less formal and non-scheduled, more emphasis is placed on conversation and 'chat' as a means of obtaining information; and
- open-ended questions allow the respondent to express his/her answers as freely as is wished and with as much detail and complexity, as long or as short, as he/she feels is appropriate.

In the light of the above, the interviews conducted in this study were based on an informal unstructured and semi-structured design. The interviews were tape recorded, transcribed and analysed using qualitative methods of data analysis.

Despite the careful planning and choice of type of interview, problems were experienced. In the words of Fontana & Frey (1994: 361), "asking questions and getting answers is a much harder task than it may seem at first." I did not find interviewing children easy or unproblematic. The reasons for this were as follows:

- It was difficult to listen and write.

  Yin (1989) stresses the importance of the interviewer making notes during the interview. I found this difficult to do because in talking to the child about their drawings and written responses, I had to ensure that the correct drawing/response was in front of the child and that the picture being discussed was available. It was not possible to make notes at the same time. When I did try to write something

down, it seemed to distract the child and in one case seemed to make the child anxious. I thus had to rely on the tape recordings for all my information.

- The tape recorder was a distraction.
  Before each interview the child's permission to use the tape recorder was obtained. The tape recorder appeared to be a source of distraction, more so for some than others. This is evident from the way in which the some of the children responded more freely and more confidently as the interview progressed.

- Open ended questions did not always appear to be appropriate.
  It is claimed that open-ended questions relieve the anxiety of respondents by allowing them to speak freely (Bless & Higson Smith 1995: 106). I have doubts about this claim, for my experience was that two of the children found it difficult to 'talk freely' and I suspect that had the questions been more structured this problem might have been alleviated. I found myself putting words into the child's mouth, becoming impatient when a response was not forthcoming, and at a loss for appropriate words when a child appeared not to grasp what was being asked.

- The children were unfamiliar with the one-to-one nature of an interview.
  I underestimated the difficulty a child would experience with a one-to-one interview situation. Despite Hopkin's (1993) warning, I assumed that the children would be uninhibited and responsive but this was not always the case. It would appear from the responses received in two of the interviews that some children have never experienced an intense one-to-one conversation with a familiar or an unfamiliar adult. These two children seemed to find the interview situation stressful and this may well have inhibited their responses.

Numerous informal discussions were held with the teacher for the following purposes:

- to identify the insights she had gained from the research process;
- to establish whether or not the process had informed, challenged or changed her perceptions of the nature and importance of spatial skills and concepts associated

specifically with pictures; and

- to obtain feedback and evaluation of the process and the product of the study.

3.7. THE DESIGN OF THE RESEARCH INSTRUMENTS

3.7.1. The diagnostic activities

The instructions and photograph for each of the eight 'island' tasks are included in the Appendices (see Appendix 4). Fig. 3.2. showed the spatial skills and concepts associated with the 'island' tasks, the nature and purpose of each of which is explained in Chapter 4.

The photographs used in Diagnostic Activity Two, are included in the Appendices (see Appendix 5). These photographs were selected in consultation with the teacher. Fig. 3.3. indicates the nature of each photograph. The photographs were chosen because of the different (sometimes unusual) perspectives and scales which they showed, as well as for the variety of environmental problems which some of them revealed. Their selection was also influenced by the amount of detail they contained, what was implied in the picture, their distinct contrast between foreground and background, or because they could be viewed as ambiguous.

3.7.2. Interviews conducted with the purposive sample

As explained in Section 3.6.2., the first part of the interview was unstructured and involved 'chatting' about the child's responses to the two diagnostic activities. There were no set questions; the child was simply asked to 'tell me more' about his drawings and written responses and depending on what emerged, further questions were asked.

The second part of the interview was semi-structured in that it consisted of a series of focused questions which each child was asked. Table 3.3. indicates the topics addressed in the second part of the interview.

- Reading experiences both in their early childhood and at present. This included asking who read to them; the type of books read; whether they contained pictures and if so, whether these were part of the reading experience; whether they read now; the type of books they enjoy reading. The children were also asked to describe their reading homework practices including the extent to which their reading was supervised and the extent to which the pictures in the reader were discussed.
- Toys and games played during early childhood and at present, including jigsaw puzzles, Lego, model building/construction toys; board games and dinkie cars. The extent to which they had been guided or taught to play these games or to follow the instructions, by adults and/or others including pre-school teachers.
- Television. The amount watched and type of programmes preferred.
- The nature and extent of their active encounters within the local environment. This included finding out how they got to and from school as well as whether they walked or cycled in their immediate and local environment.

Table 3.3. The nature of the questions asked in the interview

The purpose of asking these questions was to develop a more holistic picture of the child and perhaps isolate factors which may have enhanced or impeded their ability to utilise and apply spatial skills in both the diagnostic activities, as well as their ability to make sense of the pictures. Extracts from the interview transcripts have been included in the Appendices (see Appendix 6).

3.8. TRIANGULATION

The notion of the researcher using herself as well as others as "the primary data-gathering instrument," is not without perceived weaknesses. According to Lincoln & Guba (1985: 108), "investigator bias" needs to be addressed in order to enhance trustworthiness. This study employs combined levels of triangulation to counter the effects of subjectivity (Cohen & Manion 1989).

Denzin (1994: 214) identifies different types of triangulation, of which the following were relevant to this study:

- Data triangulation, namely the use of a variety of data sources which allows for

cross checking of data obtained from multiple sources.

Section 3.6. revealed how the study employed multiple data collection methods. By using four data collecting methods, namely classroom observations, document analysis, field notes made by non-participant observers, and in-depth focused interviews, methodological triangulation was facilitated. In this way the possible problem of distortion or bias which may result from employing a single method of data collection was overcome. Further, it allowed me to make use of quantitative as well as qualitative data obtained from two or more methods of data collection (Cohen & Manion 1989).

- Investigator triangulation, namely the use of several different researchers or evaluators.

  In addition to myself as a participant observer, the teacher and pre-service teachers were used as non-participant observers to counteract the possible effects of subjectivity. This allowed for objective outsiders' opinions on the data and was a way of validating the data.

3.9. SUMMARY

This chapter has described and justified the methodology used in this study. More specifically, it has revealed that this research:

- is qualitative and located within the interpretive paradigm;
- is a small-scale investigation which uses a case study research method;
- uses field methods of data collecting based on direct observation and interviews;
- uses data obtained from multiple sources and interpreted by multiple voices;
- employs various methods of triangulation to counteract the effects of subjectivity;
- is aware of and has attempted to address ethical issues.

CHAPTER FOUR

DATA ANALYSIS: DIAGNOSTIC ACTIVITY ONE

4.1. INTRODUCTION

Chapters Four and Five comprise an analysis and discussion of the two diagnostic activities that constituted the first stage of the investigation. Guided by Molyneux & Tolley (1978) and Catling's (1996) suggestions, as explained in Chapter 2, the two diagnostic activities were designed, to reveal the children's spatial skill development through identifying and describing what skills the children used, how they utilised and applied these skills, and the difficulties they experienced when encoding spatial information (Diagnostic Activity One) and when reading and interpreting pictures (Diagnostic Activity Two). The nature, purpose and organisation of each of the diagnostic activities was summarised in Figs. 3.2. and 3.3. in Chapter 3. The diagrams show how the two activities complement each other.

This chapter deals with an analysis and discussion of the data obtained from Diagnostic Activity One, focusing on the spatial perceptual skills and concepts shown in Fig.2.2. The data obtained from the various tasks which constituted Diagnostic Activity One was analysed and discussed in terms of both the children's ability to recognise and utilise the relevant skills and the efficiency with which they were able to apply the skills to the task at hand. Thus trends and patterns were identified in terms of

- *what* skills and combinations of skills were recognised and utilised in each task; and
- *how* the skills were used or, to put it differently, the level of efficiency with which the skills were utilised and applied.

Trends and patterns were also identified on a number of levels, namely within

- a specific age group (10/11 year olds);
- a specific class; and
- individual children.

In Chapter 5, the findings arising from the first activity are compared with those from the second diagnostic activity in order to inform the second more focused stage of the investigation, namely in-depth interviews with a purposive sample.

4.2. DIAGNOSTIC ACTIVITY ONE

Photographs and instructions for each of the activities are included in the Appendices (see Appendix 4).

4.2.1. THE SHAPE SORTER TASK

This task was designed to illuminate the skills children utilised when placing 3-D shapes into the matching 2-D holes of a shape sorter ball. The activity required the children to utilise a number of spatial perceptual skills which are shown in Fig. 2.2., namely:

- identifying and discriminating between different shapes;
- matching 3-D shapes to the 2-D shape on the sorter;
- selecting and judging shapes;
- orientating the sorter; and
- hand-eye co-ordination and fine motor skills.

In order to perform this task, the children needed to recognise spatial characteristics, to utilise and apply the skills listed above and to understand the spatial concepts associated with these skills. The latter included understanding spatial location, distribution and relationships, and the ability to make spatial inferences, as shown in Fig. 2.2. The children worked in pairs with each partner taking a turn individually. Each child had two attempts at placing the shapes into the sorter. Times were recorded for each attempt.

Results:

Summary of the results

	First attempt	**Second attempt**
Average time:	29,5 sec	26,25 sec
Fastest time:	20,8 sec	20,9 sec
Slowest time:	44,09 sec	44,2 sec

- All the children completed the task but the time taken varied considerably.
  For Dale, the child with the fastest time, the non-participant observer noted: "He looks at the hole shapes and then finds the shapes on the floor," and "before he starts he lays all the shapes on the floor and touches them... looking." From this one may infer that this child recognised ("looks at the hole... finds the shapes"), organised and sorted the shapes before beginning. This suggests pre-thinking, planning and strategising ("lays them on the floor and touches them..."). The child not only identified and matched the 3-D shapes to the 2-D shape sorter holes but he applied the skills efficiently to the task at hand and therefore performed the task with ease and speed.

  For Craig, the child with the slowest time, the non-participant observer noted: "He tends to pick up the shapes and then find the holes. He shouts at the shapes to get in... He took a while - he just can't seem to find the holes at times." From this one may infer that this child recognised and identified the shapes ("tends to pick up the shapes and then find the hole") but did not have a strategy for applying the skill ("he shouts at the shapes to get in...") to perform the task. Further, he seemed clumsy and possibly lacking in fine motor skills and as a result battled to complete the activity.

- All but one improved their time in the second attempt.
  Of the 15 children who improved their time in the second attempt, 4 improved by 10 sec or more and 11 improved by less than 10 sec. There is evidence that in all but one case, performance improves with practice. One child took longer in the second attempt (31,5 sec to 44,09 sec). The non-participant observer noted: "Craig goes - can't seem to find the holes so his partner shows him" (first attempt). And "Chris hands Craig the shapes but he does struggle - getting irate. Time was worse!" (second attempt). These comments and the times recorded suggest that this child was not familiar with the activity and apparently struggled to match the 3-D shapes to the 2-D shapes on the sorter. His partner helped him by pre-selecting the shapes for him, but even then the child battled to get them to fit. In this instance, practice did not improve performance, and so the pattern emerging from this child may be viewed as 'atypical' in relation to that emerging from the rest of the class.

The results revealed that all the children managed to complete the task, although the time taken to do so varied. This suggests that there were different levels of skill competency within the class. All the children were able to recognise and identify the skills necessary for the task in that all were able to match the shape to the hole on the shape sorter. However, their ability to utilise and apply the skill to the task on hand was more efficient if the child was able to implement some or other type of strategy for applying the skills. In Chapter 2, it was argued that spatial knowledge is dependent on both spatial perceptual skills and on spatial conceptual understanding. It was also argued that the ability to use a strategy for applying a skill only comes with conceptual understanding. The children who performed the above task more efficiently were those who had some or other strategy for applying the skill. From this one may infer that their conceptual understanding was more developed than that of their peers. As a result they were able to perform the task successfully and with ease.

4.2.2. PUZZLE ACTIVITY

This activity required each pair to assemble as many pieces of a puzzle as possible within a 10 min period. The puzzle box showing the complete picture was available as a guide. Doing a puzzle requires recognition and utilisation of a number of different spatial perceptual skills, namely:

- the ability to recognise and match and discriminate and combine colour, shape, patterns;
- the ability to identify relationships;
- the ability to classify pieces according to the above;
- hand eye co-ordination and fine motor skills;
- the ability to orientate the pieces according to the picture shown on the puzzle box; and
- the ability to attend to and transcribe scale from the picture on the box to the pieces.

In order to apply the skills efficiently, the children had to understand the spatial concepts in which these skills are embedded (as shown in Fig. 2.2.).

Results

- Each pair managed to assemble some of the puzzle pieces. A range in number of pieces assembled by each pair was recorded.

  The number of pieces assembled ranged from 19 to 59. The average number of pieces assembled was 38. From this one may infer that while all the children recognised and utilised the skills linked to this activity, how they utilised and applied the skills varied according to the level of efficiency with which they were able to perform the task.

For the pair with the lowest score, the non-participant observer noted:

> They go for the straight edges first. Also the corners. After a while, Craig looks at the picture. Before completing one side, they start with pieces in the middle. Chris loses interest in the sky... moves on to other pieces. Suddenly abandons these. Craig seems to be struggling a bit.

The above observation suggests that this pair:

- had a strategy ("straight edges first") but were unable to apply it;
- chose to work individually - there was little evidence of either supporting, guiding or enhancing the attempts of the other;
- recognised and matched shapes ("straight edges and corners") but did not seem to apply this to the task at hand ("before completing one side, they started with pieces in the middle");
- recognised the relationship between the picture ("looks at the picture") and the pieces but did not understand it as this recognition only occurred after they had begun and did not appear to be referred to again;
- appeared to be unable to sustain their interest in one area for any period of time ("loses interest... moves on to other pieces")
- recognised and matched different colours ("sky") but this was not sustained ("loses interest after a while"); and
- were easily distracted, tending to jump from one section to another before completing the section on which they were working.

The approach to the task, in this instance, was individualistic. Each child appeared to recognise and know the procedures for puzzle building but was inconsistent in the application of these. In other words, they knew the skills, but because they were unable to organise and implement them, they performed the task with less efficiency and success. From this one may infer that these children did not understand the conceptual basis of the skills. Further, the efficiency with which they were able to utilise the various skills appeared to have been hampered by their electing to work individually.

For the pair with the highest score (59), the non-participant observer noted:

Bill says he'll get the side pieces. Rob goes into fitting pieces together. They start with the sky. They work together. Consult the picture quite a lot. Rob moves down the puzzle, making a border. They put pieces together that match, even if they do not fit what is already there. They complete the border and move inwards.

The above observation suggests that this pair:

- appeared to have developed and implemented a strategy/plan of action which included working together as a team;
- recognised the relationship between the pieces and the picture on the box and used the latter to guide their efforts;
- recognised and matched patterns and shape (the borders);
- recognised and matched colour (the sky);
- concentrated on the task at hand; and
- appeared to have good hand-eye co-ordination and fine motor skills in that they managed to put the pieces together with ease.

The approach to learning in this instance was co-operative. From a social constructivist point of view, its success might have been predicted, since in that paradigm, learning is seen to take place through social interaction, discussion and sharing of ideas. Importantly, both children appeared not only to recognise the skills necessary for the task but also to understand how best to apply them. The fact that they assisted one another suggests that they recognised and understood that through a co-operative effort it would be possible to

utilise and apply the skills more efficiently. The benefits of working together and of sharing ideas are reflected in their score. Finally, the way in which the pair set about the task suggests that they understood the conceptual basis of jigsaw puzzle building. In other words, they apparently understood the concepts of spatial location, distribution and relationships, and were able to make spatial inferences as shown in Fig. 2.2. Consequently, they were able to implement all the procedures for building a puzzle in a skilful and efficient way.

The findings reveal that all the children in the class were able to assemble part of the puzzle, that is, they all recognised the skills and procedures for puzzle building and were able to perform the task. However, the range of scores recorded suggests that despite their knowing what to do, the levels of efficiency, consistency and success with which they were able to apply what they knew varied considerably. The pair who worked co-operatively, utilising and applying a combination of skills, displayed the highest level of efficiency and achieved the highest score. There is evidence in the non-participant observers' comments suggesting that these children were efficient because they were applying the skills with conceptual understanding rather than in a mechanical way. This finding supports Griffith's claim (Section 2.5.1. in Chapter 2) that knowledge should be viewed in a Rylian sense as being composed of skills embedded within conceptual understanding.

4.2.3. PUZZLE ACTIVITY II

This activity was similar to but more difficult than the previous puzzle activity. In this instance the puzzle consisted of a colour poster depicting a somewhat more abstract and symbolic picture. It had been cut up into pieces of different sizes, all of which had straight edges. Each pair was required to record the time it took to assemble and complete the picture. Approximately 12 min was allocated for this task. If the task was completed within the time allocated, the children were told to have a second attempt and to record the time.

This task required that the children assemble the pieces without relying on cues provided by shape (which in a 'normal' puzzle provides cues for the border) and without the guidance

of a complete picture (as in task 4.2.2). Further the abstract, unfamiliar nature of the puzzle made it more challenging in that the children had no recognisable pictures/images to aid them. They had to recognise and use colour and pattern as cues. The task required the recognition and utilisation of the following skills:

- the ability to recognise, match, discriminate and combine colour, patterns;
- the ability to identify relationships;
- the ability to orientate the figures/symbols shown on the pieces;
- the ability to classify the pieces according to the above; and
- hand eye co-ordination and fine motor skills.

The activity also required an understanding of the spatial concepts associated with the skills identified above. A child may, for example, recognise different shapes and colours in the puzzle pictures but his/her ability to utilise the skill is dependent on understanding the concept of spatial distribution and spatial relationships, as shown in Fig. 2.2.

Results

- All the pairs completed the picture in the time allocated. Two pairs completed the picture a second time.
- A range of times was recorded.
  Times range from 12,2 min to 3,39 min. The average time taken was 7,1 min. The two pairs who completed the puzzle a second time, both did so in less time.

For the pair who took the shortest time (3,39 min), the non-participant observer noted:

> Started at the bottom of the picture and moved to the middle. Scott noted the difference between flowers with black background and white background. Looked for symbolism in the picture.

For the pair who took the longest time (12,2 min), the non-participant observer noted:

> Struggled half way through. With one piece neither could see that it was at the wrong angle. Because the bottom was wrong, they thought pieces put in the right places were wrong. Craig looked at the shapes and colour and finally

> picked one that fitted. Craig put pieces together outside the puzzle. Chris followed. Couldn't comprehend that a piece they had put in was wrong and therefore if the other pieces didn't fit, it was because they were 'too big'.

These observations suggest that the pair who recorded the fastest time appeared more organised in that they seemed to know how to tackle the activity and had a strategy: "started at the bottom." Further, they utilised all the skills necessary for this task and they understood how to apply the skills within a broader conceptual framework. They identified, discriminated and matched colours and patterns. They also recognised and understood the significance of the symbolic picture in determining how they searched for matching pieces.

Initially, the pair who recorded the slowest time did not discriminate between the different shaped pieces and thus could not understand when the pieces would not fit. Without the concrete cues provided by a complete picture and because of the symbolic nature of the picture in this puzzle, this task required children to recognise and utilise colour and pattern as opposed to a picture. At first, this pair did not recognise or understand the need for these skills to be utilised. They experienced difficulty with size discrimination, orientation and pattern matching. It may be inferred that although they had recognised and applied the skills in the previous puzzle activity, they made the mis-assumption that the same skills could be utilised in this puzzle activity. It was only "half way through" that they seemed to realise that their 'usual' approach to puzzle building needed modification because of the nature of this particular puzzle. From this one may infer that the 'skill' they possessed in this instance comprised a physical activity - the doing of a puzzle - without an understanding of how to apply it. In Chapter 2, it was argued that if a skill is seen as an ability that comes from practice or training and involves minimal understanding, there is a danger that this, in the context of education, might result in the devaluation of the reasoning and understanding on which proper use of the skills depends. If, as the above findings suggest, this pair do not understand the spatial concepts necessary for this task, then we need to ask: to what extent will this influence their ability to communicate spatial information about the environment in graphic as well as other forms of communication?

The non-participant observer's comments suggest that, lacking spatial conceptual understanding, Craig and Chris were initially unable to recognise appropriate skills for this