Peter Moodie's book

Reasoning skills and the curriculum

(A final report of the Threshold Project)

C.A. Macdonald

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hair: An analysis of
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PREFACE

The Threshold Project had its beginnings in a pilot project that was conducted in the Institute for Research into Language and the Arts in 1985. It emerged from this early research that black children are experiencing difficulties with the change of medium of instruction in their fifth year of schooling. At first glance it may have seemed that these difficulties arise purely as a result of ineffective language teaching methods. However, the complex nexus of factors that constitutes black primary education required a closer look at different aspects of the total teaching-learning situation.

The Anglo-American and De Beer's Chairman's Educational Trust Fund agreed to provide funding to the Institute for the Study of English in Africa to commission the Institute for Research into Language and the Arts to undertake a three-year project on the problems which had been identified. The research was undertaken under the project leadership of Dr C.A. Macdonald of the Division of Sociolinguistic and Psycholinguistic Research.

In the course of the project a broad range of tasks was covered, including language testing, cognitive developmental research, materials development and classroom practices. The results of the research are contained in five final reports and a main report which attempt to contextualise the understandings reached in the larger social situation in which the research was located; there was also a serious endeavour to locate the research in the context of state of the art thinking in specific aspects of education, language teaching and testing theory, and cross-cultural cognitive developmental research. The intention behind this broad endeavour is to open up questions of educational theory and practice for further discussion and research on an academic level, and also to provide a knowledge base for serious thinking on develpmental issues in the rapidly changing situation in Southern Africa.

The HSRC expresses its sincere appreciation to the Chairman's Fund for its funding of such a seminal project, and to the Institute for the Study of English in Africa for the invaluable part which its representatives played on the advisory committee of the project.

A final word of appreciation goes to Dr Carol Macdonald for the important role that she played throughout in the planning, conducting and completion of this groundbreaking project; also to Dr Rose Morris under whose aegis the major part of the project was conducted.

K.P. PRINSLOO
EXECUTIVE DIRECTOR: IRLA

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ABSTRACT

As part of the Threshold Project which examines the nature and extent of
the problems that children experience when they make the transition to
English as the medium of instruction in Standard Three, it was thought
that reasoning skills might be an explanatory construct. The way in
which we thought cross-cultural cognitive research would help us would
be in analysing how children characteristically approach different
problem-solving tasks. Part of the research that was conducted on the
Threshold Project is contextualised in an analysis of an aspect of in-
formation processing systems (IPS) approaches (specifically
metacognition); another part of the research is presented as cross-
cultural replication of a neo-Piagetian approach. The empirical re-
search is integrated into a general developmental paradigm that is
described.

One main section of the analysis is devoted to the various contributors
to cognitive developmental theory. The conceptions of cognitive devel-
opment that are of potential interest are the genetic epistemology of
Jean Piaget, IPS approaches, including the recent intense focus on
metacognition, Pascuale-Leone's Theory of Constructive Operators, the
developmental paradigm of Vygotsky, and its explication by researchers
from the University of Natal and the applications of these theories in a
cross-cultural situation. The central constructs of each theory are ex-
amined, together with an account of the posited mechanisms for change.
At the end of this section we offer a summary account of what we con-
sider to be points of agreement between the theories, as well as the
constructs that may be useful in our situation. The nature and kinds of
intervention that are consonant with this developmental paradigm are
clearly outlined: the nature of the task takes primacy over indigenous
patterns of mediation.

The second main section of the analysis is devoted to a description of
some new approaches to the teaching of thinking. These approaches can
be broadly divided into five categories: cognitive operations ap-
proaches (e.g. Feuerstein), heuristics-oriented approaches (e.g. de
Bono), formal thinking approaches (used at college level), thinking
through language (principally the work of Bereiter and Scardamalia on
writing skills), and thinking about thinking (principally the work of
Garner on metacognition and reading). Exponents of these five ap-
proaches are instantiated (as indicated) and a brief appraisal is made
of each of them, together with a comparative appraisal. Particular at-
tention is paid to productive aspects of information processing ap-
proaches which allow us to do meaningful task analyses, of central
school learning tasks, such as reading and writing, as well as giving us
an explanatory account of the problem of "inert knowledge" (i.e. the ap-
parent unusability of school-derived knowledge), which is the plague of
much of conventional education. The approaches are appraised against
the theoretical background set up in the first section.

In the final section of the report recent developments in bilingual edu-
cation theory are explicated with reference to their applicability to
the child's learning task in our situation. The concepts of "basic
interpersonal communicative skills" and "cognitive academic language

proficiency" amongst others are extended to show the changing nature of the task; communicative language teaching principles have to accommodate to cognitive strategies general to all formal learning. An outline of a model accommodating language and cognitive aspects is given as programmatic to future research.

EKSERP

As deel van die Threshold-projek wat die aard en omvang ondersoek van die probleme wat kinders ondervind wanneer hulle in standerd drie na Engels as die onderrigmedium oorskakel, is geoordeel dat redeneervaardighede 'n verduidelikende konstruk kan wees. Daar is verwag dat kruiskulturele kognitiewe navorsing nuttig sou wees in 'n ontleding van die kenmerkende wyse waarop kinders verskillende probleemoplossingstake aanpak. Een deel van die navorsing wat in die Threshold-projek onderneem is, is gekontekstualiseer in 'n ontleding van 'n aspek van benaderings tot inligtingverwerkingstelsels (IVS) (spesifiek metakognisie), terwyl nog 'n deel van die navorsing as 'n kruiskulturele replisering van 'n neo-Piaget-benadering aangebied word. Die empiriese navorsing is geïntegreer in 'n algemene ontwikkelingsparadigma wat beskryf word.

Een hoofafdeling van die ontleding word gewy aan die verskillende bydraers tot kognitiewe ontwikkelingsteorie. Die konsepte van kognitiewe ontwikkeling wat van potensiële belang is, is die genetiese epistemologie van Jean Piaget, IVS-benaderings, met inbegrip van die onlangse intense fokus op metakognisie, Pascuale-Leone se Teorie van Konstruktiewe Operateurs, die ontwikkelingsparadigma van Vygotsky, en die verwerking daarvan deur navorsers van die Universiteit van Natal en die toepassings van hierdie teorieë in 'n kruiskulturele situasie. Die sentrale konstrukte van elke teorie word ondersoek, en verslag word gedoen oor die gepostuleerde meganismes ter verandering. Aan die einde van hierdie afdeling van die verslag word 'n opsommende oorsig gebied van wat as die punte van ooreenstemming tussen die teorieë beskou word, asook die konstrukte wat in ons situasie nuttig kan wees. Die aard van en die soorte ingryping wat met hierdie ontwikkelingsparadigmas saamval, word duidelik omlyn: die aard van die taak verkry voorkeur bo inheemse bemiddelingspatrone.

Die tweede hoofafdeling van die ontleding word gewy aan 'n beskrywing van enkele nuwe benaderings tot onderrig in denke. Hierdie benaderings kan breedweg in vyf kategorieë verdeel word: kognitiewe bewerkingsbenaderings (bv. Feuerstein), heuristiesgeoriënteerde benaderings (bv. De Bono), formele denkbenaderings (gebruik op kollegevlak), denke deur taal (hoofsaaklik die werk van Bereiter en Scardamalia oor skryfvaardighede), en denke oor denke (hoofsaaklik die werk van Garner oor metakognisie en lees). Toepassings deur aanhangers van hierdie vyf benaderings word beskryf en 'n bondige beoordeling van elk word saam met 'n vergelykende beoordeling verskaf. Besondere aandag word geskenk aan produktiewe aspekte van inligtingsverwerkingbenaderings wat sinvolle taakontledings van sentrale skoolleertake soos lees en skryf moontlik maak en 'n verduidelikende verklaring bied van die probleme van "trae kennis" (d.w.s. die skynbare onbenutbaarheid van kennis wat op skool verkry word), wat 'n groot gedeelte van konvensionele onderwys teister. Die benaderings word beoordeel teen die teoretiese agtergrond wat in die eerste afdeling uiteengesit is.

In die laaste afdeling van die verslag word onlangse ontwikkelings in tweetalige onderwysteorie verduidelik met verwysing na die toepaslikheid daarvan in die kind se leertaak in die Suid-Afrikaanse situasie. Die konsepte van "basiese interpersoonlike kommunikatiewe vaardighede" en "kognitiewe akademiese taalvaardigheid", onder andere, word uitgebrei om die veranderende aard van die taak aan te toon; kommunikatiewe taalonderrigbeginsels moet ruimte bied vir kognitiewe strategieë wat algemeen is aan alle formele leer. 'n Raamwerk van 'n model wat kognitiewe en taalaspekte akkommodeer, word met die oog op rigtinggewing vir toekomstige navorsing uiteengesit.

CONTENTS

Tasks that
mediate
10 ① a learner.

CHAPTER 1

INTRODUCTION

1.1 REASONING AS A CONSTRUCT ON THE THRESHOLD PROJECT

The superordinate problem that the Threshold Project has addressed itself to is the nature of the language and learning difficulties that Standard Three children experience when they change from the mother tongue to English as a medium of instruction.

We were concerned to conceptualise our research in a way which would facilitate the design of coherent and constructive strategies for change. It was felt that this would be best achieved by focussing on five interrelated factors, namely, the linguistic difficulties experienced by the children, conceptual styles which might be culture specific, problems with content subject textbooks, disparities between English learned as a subject and English as required across the curriculum; and finally, school-based learning experiences. These factors were formulated into five main objectives, which became the foci of organisation for the Threshold Project. The objectives are as follows:

1. To establish the nature and extent of the linguistic abilities of the Black pupils in Standards Two to Three. The corresponding final report is entitled *English Language Skills Evaluation*.

2. To establish the nature of pupils' cognitive capacities using a model of natural thought which has implications for curriculum design. In particular we were interested in establishing how pupils characteristically approach certain types of problem-solving tasks. (The current report.)

3. To develop a description of the present expectations of syllabus makers and textbook writers regarding the competence in English of children in Standard Three who are beginning to learn their subjects through the medium of English, and to relate such a description to the content of two lower-primary English courses in such a way as to illuminate possible disparities between the English and content-subject courses. The corresponding final report is entitled *Disparities between English as a subject and English as the medium of learning*.

4. To describe the contribution of school-based learning experiences to the specific nature of abilities of children in Standard Three. The corresponding final report is entitled *School-Based Learning Experiences*.

5. To produce guidelines or principles intended to inform syllabus makers and curriculum developers. The corresponding final report is entitled The Consolidated Main Report , which also makes reference to the previously mentioned four final reports, along with another entitled *Standard Three General Science Research*.

This report addresses the second aim of the project, namely, the pupils' cognitive development, principally as it relates to their school-based learning experiences in a social context. It has been our contention that there is a complex relationship between the language media and the child's conceptual understanding of the content of various subjects, a relationship which has been inadequately addressed, and which probably is further compounding the child's (and the curriculum designer's) difficulties. We try to extend recent thinking in this area (cf. Chapter Four).

We are bound then to look at the relationship between the mother tongue (L1) and the second language (L2) and their interdependence with conceptual structures. What we require is a statement of a coherent theory, one which either gives a satisfactory account of the relationship between language and cognition or one that opens itself to such an account. But we need to look further too, at the relationship between cognitive processes and education. Turner (1984, p.13) has this to say:

If education is seen as being, at least in part, the intentional transmission of knowledge and understanding in order to develop powers of thought of the recipient, then an understanding of the processes of cognitive development would seem to be an essential prerequisite for such an enterprise. However, although there are some educational implications following from our understanding of the characteristic modes of thought of individuals of various ages, the connection between theory and practice is neither conceptually nor operationally clear.

Before we look at reasons why the conceptual connections between education and cognitive theory are not always clear, we need to add a fourth factor which is operative in our (and indeed, every) situation. And that is the phenomenon of culture, in which all forms of language, cognition and education are embedded.

To look first at relations between cognitive theory and education in general terms: let us suppose that experimental work with children shows us that they can carry out type X tasks when they use Y strategies which presuppose the existence of type Z structures. What is the educationist supposed to make of such information? It will be useful to him if he conceptualises the child's learning task in the same way as the cognitive developmentalist does. Otherwise not. It may be that the educationist is concerned to foster the child's learning and considerations of the child's developmental path may well be secondary. The psychologist may help the educationist if he is able to give a coherent account of how to foster development. (The distinction between learning and development is one which we take up in detail later; it helps us, for example, to understand cultural differences in performance on equivalent tasks.)

It will not help the educationist if cognitive developmentalists are simply concerned to hand out interesting pieces of information about children. As Turner (ibid) points out, if isolated aspects of theory are selected and applied to classroom practice, then it is unlikely that they will have much influence, simply because they are part of a wider

theory and only have meaning in such a context. What is required is a theory of cognition in classroom practice.

Another difficulty posited by Turner (ibid) in applying psychologists' understanding of cognitive development directly to education is that the former are concerned with the processes whereby we come to know, whereas curriculum designers often start from the outcomes of such processes, as in seeking to develop numeracy or literacy. Educationists may presuppose that practising these skills which define the outcome of the learning process (e.g. practising arithmetic procedures) will facilitate the learning process itself. A psychologist on the other hand might prefer that the pupils have the experience and practice the skills which are thought to be a precondition for developing certain forms of human understanding. Recently, however, (as we shall see in Chapter 3) psychologists have been able to identify aspects of the instructional process of complex activities such as expository writing which should directly inform teaching activities. But, however elegant and powerful cognitive theories may seem to be, they should not be considered as a comprehensive account of institutional learning, which in itself is a complex social form.

1.2 CURRENT SOCIETAL INTEREST IN REASONING SKILLS

Much of the current interest in reasoning skills, and this is considerable (cf. Nickerson, Perkins and Smith, 1985), is not centred round the issue, as we have briefly sketched it in the section above, that is, in general theoretical terms. Rather, it is seen in much broader terms. The ability to think effectively has always been important (how else would we get on in society), but it seems to have become even more important in recent times. Now it seems urgent that we should have the ability to adapt, to learn new skills quickly, and apply old knowledge in new ways.

Given the gargantuan development of the communication media, we are now exposed on all sides to arguments, and efforts to persuade. Working out what we ought to believe is especially important; to do this in a rational way, according to Nickerson, et al (ibid) requires the ability to judge the plausibility of specific assertions, to weigh evidence, to assess the logical soundness of inferences, to construct arguments and alternative hypotheses, in short - to think logically.[1]

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[1] It is ironic that we should be writing about the importance of being able to think logically, when this is predicated on the assumption that we should actually be supplied with "assertions", "evidence" and explicit "inferences", none of which is necessarily true in our current socio-political climate.

A productive distinction has been made by Botkin, Elmandjra and Malitza (1979) between maintenance and innovative learning. In maintenance learning, there is the acquisition of fixed outlooks, methods, rules for dealing with known and recurring situations. This kind of learning enhances our problem-solving ability for problems that are "given". This type of learning is designed to maintain an existing system or an established way of life.

On the other hand, in innovative learning, assumptions are questioned, even those of long standing, and new perspectives are sought. This kind of learning is required if we are to cope with the problem of anticipating and dealing effectively with turbulence and change. It goes without saying, that in the larger South African context innovative learning is required. But at the micro-level, we will find that it is critical that children are led towards innovative learning in a context that in different ways has sought to maintain the status quo of maintenance learning. This tendency has not necessarily been malign or even conscious: but children have been learning in ways which do not help them to adapt to the changing demands of the work place.

The first two sections of this chapter have mirrored a dichotomy which is reflected in the literature. By and large there is no transaction between the research in cross-cultural developmental psychology and the now burgeoning "industry" of teaching thinking skills which has developed largely in the West. By way of illustration, the massive review which Nickerson et al were commissioned to write on teaching thinking skills makes only one passing reference to the teaching of thinking in cross-cultural contexts. In fact we might be so bold as to say, that where this has been applied, it has not been done in any considered way. It is part of the purpose of this report to try to apply the insights of cognitive theory to the concept of teaching thinking in a way which has the most productive application in our educational situation.

1.3 CULTURE AND THE CURRICULUM: AN OVERVIEW STATEMENT

The ostensible purpose of this report is to relate how children do particular problem solving tasks, and how they might do their tasks differently from Western middle-class children, who are generally successful at doing their tasks. The principal idea is to uncover implicit assumptions which children bring to the situation that enhance or inhibit effective performance. In conducting such research, one has to grasp the nettle of the relationship between the child's natal culture and the curriculum. Western middle class children by and large do their learning tasks effectively because formal schooling is part of the same socio-historical trajectory as other aspects of their culture. The position taken - indeed the central tenet - in this report is that culture and cognition are inextricably intertwined, and that well-meaning attempts to separate them into some kind of causal relationship lands one in the position of having to adopt a philosophy (or ideology) of cultural relativism. In Western countries with ethnic minority populations

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such relativism is congruent with left wing thinking; in South Africa, such relativism lands us - albeit unexpectedly - in a position of neo-apartheid thinking, and we run the risk of dressing up the bantu education dolly in new clothes. (cf. Sections 2.5.1 and 2.5.2 for a detailed theoretical discussion based on cross-cultural cognitive issues.)

Musgrove (1982) has very clearly laid out the recent history of the relationship between culture, relativism and the curriculum. Starting from an early, very simple definitional notion of culture as the customs of a group of people, the notion culture has been massively reified - it has been treated as a thing, separate from individuals but with power, influences and even rights over them. On the reified reading, it is outside people and has causal power over them, for example making them do well or badly at school, or making them become delinquents. Musgrove sees Durkheim (1938) as having been extremely influential in his account of culture as 'social facts', external to the individual, and endowed with coercive power which acts on an individual independent even of his individual will.

Musgrove (p. 115) says that "there has been probably no more popular concept than 'culture' in twentieth century social science. It has been all pervasive and has seemed to explain everything". He refers to works on the sociology of education, juvenile delinquency, and even Marxist 'class cultures' (Mungham and Pearson, 1976; Hall and Jefferson, 1976). A hundred years ago, it was first allowed that other non-western people actually had a culture, although these cultures were rank ordered with confidence (Tylor, 1871). A further step was necessary to arrive at the neutral, non-normative idea of culture which prevails today.

Musgrove sees the conceptual refinements of recent years as including a focus on the subjective aspects of culture, with anthropologists trying to get "inside" people's cultures, describing the members' constructed or negotiated meanings. Its symbolic nature - what is says - is given emphasis (Schneider, 1968), while its utility - what it does and achieves - has been played down.

The concept of education as the maintainer and propagator of culture was for example developed in England in the 30's to the 50's by Clark (1936, 1948), who saw the first business of education as being to induce conformity in terms of the culture in which the child is to grow up. The concept of culture gained autonomy and rights: however, in doing so in the context of "multicultural" education it had the unfortunate effect of sustaining the concept of static culture and constant group membership (McLean, 1980). Contradictory to the notion of relativism is the possibility of change and progress: this contradiction is a consequence of seeing culture as a product and not as a process.

Part of the popular notion of relativism is the preclusion of the possibility of evaluating cultures relative to each other: to do this one needs a set of values that are of a higher order, values which themselves would need validating. However, Musgrove points out that cultures themselves are constantly occupied with what in relativism theory is impossible, that is, in judging, valuing and perhaps even repudiating their former selves. (An apposite case study in our context would be

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the processess of self-evaluation that the Afrikaans community has been going through, a process that is leading different sections off in different directions.)

Possibly the most powerful form of relativism is that in the realm of epistemology - where the question arises as to how we can evalute ways of thinking and forms of belief. Musgrove sees Kuhn (1962) and Winch (1958) as being the arch proponents here. Yet Kuhn (1970) himself admitted that it is possible to discern progress in later paradigms being better than earlier ones, but he insisted that it was difficult for one paradigm to understand another. Popper (1970) on the other hand thought that people brought up in different frameworks should communicate, because in this "culture clash" intellectual discussion is truly stimulated. This latter view points the way to genuine dialectic of discussion amongst people of different (everyday) cultures.

To be fair, Musgrove does admit that there is also a tradition of anti-relativism. On the epistemological level, there is the criterion of rationality - the law of non-contradiction (Lukes, 1967). In the "real world" Gellner (1968) accords supremacy to the paradigm which he refers to as "the scientific-industrial form of life". The reason why he accords it supremacy is because its rapid global diffusion is the "main event of our time". Gellner doubts whether the problem of relativism really has a formal solution: but the technical and cognitive effectiveness of scientific-industrial society makes its basic characteristics not really optional - its basic efficiency in explaining cause and effect is at the heart of its efficacy.[2]

Musgrove would argue for what he calls the dialectic of integration and particularism in education (p. 128):

> The business of the school is not to transmit any group's culture intact; but if it is to engage the minds and imaginations of its pupils it will at least start from where they are. And 'where they are' is where much of what was taken for granted in their lives is now at least implicitly challenged and made problematical.

Starting from where the pupils are not a self-evident enterprise, and require ingenuity to discover the underlying motifs of their lives. In the words of Vygotsky (for extensive discussion, see Chapter Two), we will have to start in the cultural "Zone of Proximal Development". As far as Chazan (1978) is concerned, the traditional culture should survive only where some contemporary problem refers to it and provides some "motivating tension that gives it point". Musgrove concurs with this point from his African experience. While one might be sympathetic to traditions and identity, Chazan argues that "a blind survivalist

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2 Musgrove notes whimsically that the scientific industrial form of life is the only culture that castigates itself for being ethnocentric and indulges in cultural relativism!

ethnicity is a doubtful commodity for second and third generation ethnics in open pluralistic societies". The key question in our situation is how long, and in what ways, our own society will take to become truly open.

The situation in English education, which is Musgrove's primary focus, is that the "other cultures" i.e. the West Indian, the Sikhs and the Muslims, have often been opposed to the application of the culture concept to the school curriculum (cf. for example, Stone, 1981). They have refused to be confirmed by schooling in their traditional identities. "Their culture has relevance in the curriculum only at its points of maximum tension with modernity", says Musgrove. He goes on to say (p.138):

> The school curriculum must be transformational. There can be no tincture of compromise over a core curriculum of Western science, Western mathematics, Western logic, and a Western language. But there is an extensive interface of culture contact and conflict which offers focal issues of curriculum development.

Musgrove, himself a teacher of history to African students, detailed a number of points of cultural conflict on which a "transformational" history syllabus must stand: the work ethic, concepts of liberty, wealth and equality, and notions of causality in human affairs. These apparently abstract issues arose from a detailed history syllabus which presented an alien world to the African student. Given that cultures as processes are always changing, there will be new points of tension to map, and there will always be lively issues for the curriculum.[3]

1.4 THE STRUCTURE OF THE REPORT

In this introduction we have tried to show the potential richness of this domain for the Threshold Project. Apart from our own research, we have a wealth of powerful theory about cognitive development in

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3 Perhaps this may seem remote and abstract presented in this form: but Musgrove (1955) gives a very concrete account from his early experience - "They want the full details, they wish to see how it really works, they want to understand fully the complexity of events and forces which bear upon the particular moment to produce the particular event. A detailed study of say, the anti-slavery movement would give them insight into the machinery of history. They would gain an understanding of causality at variance with their traditional philosophy of causality, witchcraft. A new culture tension would thus arise, but it is from these tensions, understood by studying the forces which created them, that a synthesis will come and a new African civilization arise".

abstracto and in a cultural context which we can examine. On the other hand we find that in the last two decades programmes have been developed that purport to facilitate the teaching of thinking skills. Are these programmes sufficiently accountable to the best that we know about cognitive development? Do they relate, in a considered way, to authentic learning tasks that children are expected to master?

In Chapter Two we shall look at aspects of intellectual competence primarily from a theoretical point of view. We look at the basic postulates of Piagetian genetic epistemology, give a brief description of aspects of information process systems (IPS) approaches, followed by an overview of the further development of certain Piagetian postulates in the Theory of Constructive Operators (Pascual-Leone). We then look at general consideration in cross-cultural psychology as percipiently analysed for us by Miller in what we have labelled for convenience "rational model theory", which lead us to make a distinction between the individual and the social, and to focus on the criterion of change or novelty. A brief overview of cross-cultural findings in the Piagetian field leaves us with one perspective which is then co-ordinated by a discussion of the Vygotskian paradigm, which has been explored on an ongoing programme at the University of Natal. The most theoretically tightly bound research conducted on the Threshold Project, using a neo-Piagetian model, is then described, and evaluated in terms of the perspectives the previous approaches have been able to introduce. At the end of this chapter we are able to make a tentative statement about the significance of cross-cultural developmental psychology for aspects of the curriculum.

In Chapter Three we attempt an overview appraisal of five approaches to the teaching of thinking skills. (These approaches are taken in general outline along the lines used by Nickerson et al, and the reader is referred to this sourcebook for information about particular programmes under the different approaches). Examples of each of these approaches are given, together with a brief reference to evaluative research which has been conducted on them, and comment on their theoretical status. The particular programmes that are described include Instrumental Enrichment, CoRT, Scardamalia and Bereiter's approach to writing, and Garner's approach to metacognition and reading. A summary appraisal of these approaches is made at the end of the chapter, specifically against the kinds of predictions made by theory considered in Chapter Two.

In Chapter Four we try to make an application of what we have described and evaluated in the previous two chapters. Firstly we look at the way in which we can justify an interest in thinking skills as a legitimate educational enterprise in our context. We then try to develop a model for the place of thinking skills in the curriculum, and how this would affect the teacher, materials, procedures and evaluation, and also the significance of motivation and affect. We end the chapter with a summary of practical implications.

Instructions to the reader

If the reader is interested in the general direction of Threshold Project thinking on reasoning skills, then he might like to start with Chapter Three and go on to Chapter Four.

If the reader is particularly interested in current theoretical issues in cross-cultural cognitive psychology, then he might simply want to read Chapters Two and Four.

If the reader wants to cover the entire report, we should like to warn him that the register in Chapter Two is very different from that of Chapter Three, since they were written for rather different purposes.

CHAPTER 2

CONCEPTIONS OF INTELLECTUAL COMPETENCE

2.1 CONCEPTIONS OF INTELLIGENCE

Most people would probably agree that there is some relationship between thinking or reasoning ability and intelligence. However difficult it is to develop a consensus definition of intelligence, there would probably be some agreement about certain abilities which characterize intelligent behaviour. Examples would be the ability to classify patterns, to modify behaviour adaptively (to learn), to reason deductively, and to reason inductively,[1] the ability to develop and use conceptual models, and to have insights (Nickerson, et al, 1985). Given these parameters, one would conclude that all human beings have these, but that they do not all have them to the same degree. Much of the interest in intelligence on the part of researchers has been motivated by the desire to understand better how and why people differ from each other in this regard (and also to predict who will be good at what, for selection purposes).

Debates about the nature of intelligence have sometimes focussed on some quite specific issues. For example, there has been the question of whether intelligence is best considered a general cognitive ability or a collection of individual abilities. A third possible view is that it includes a general ability and a collection of special abilities as well (cf. Spearman, 1923). Most designers of intelligence tests have accepted that intelligence is a multi-faceted thing, realizing this in a number of sub-tests or tasks. However, they tend to collapse performance across tasks into a final single score. But, it is possible that the trend will change to focus on the measurement of separate capacities that fall under the general heading of intelligence.

One example of this is a kit of factor-referenced tests recently released by the Educational Testing Service (1976), New Jersey. There are 72 tests for 59 aptitude factors, and the tests are thus far intended for research purposes only. The Kit has identified apparently more simple factors such as speed and flexibility of closure as well as patently more complex process such as integrative processes, general and logical reasoning. The list the ETS has produced demonstrates that intelligence must indeed be multi-facetted, but that with the statistical tools at our disposal it is difficult to partition it into a set of clearly delineated factors. One reason for this would be that the ETS adopts a psychometric approach, extracting aptitudes by factor-analysis, which is theory-neutral in this instance.

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[1] Deductive reasoning involves logical inference. One draws information from information explicitly given in premisses. Inductive reasoning involves going beyond the information given; it has to do with the discovery of rules and principles, with arguing from particular instances to the general case.

In contrast to the factor-analytic approach, there is another strong trend emerging in the research literature and that is the process approach. This approach is most clearly and readily epitomized in the work of Sternberg from Harvard. He distinguishes five different kinds of components or processes (1986):

1. Metacomponents: control processes involved in planning and decision making in problem solving;

2. Performance components: these implement plans and decisions of the metacomponent in carrying out actual tasks;

3. Acquisition components: these deal with the acquisition of new information;

4. Retention components: these retain or retrieve previously learned information, and

5. Transfer components: these carry over retained information from one context to another.

A key role is assumed for the metacomponent processes -

1. All feedback is filtered through these elements;

2. if they don't perform their function well, it won't really matter what the other elements do, and

3. they are central in understanding the nature of human intelligence.

In a recent paper (1981), Sternberg presented a view of intelligence *as a set of thinking and learning skills* which are used in academic and everyday problem solving and which can be separately diagnosed and taught. As representatives of the types of skills involved, he lists :

    *problem identification
    *problem selection
    *representation selection
    *strategy selection
    *processing allocation
    *solution monitoring
    *sensitivity to feedback, etc.

What is important to note here is the contemporary view of intelligence which enables one to identify skills that can be identified and taught. It is this type of theorizing which can allow for the possibility of teaching thinking skills. While the level at which Sternberg is working is tertiary education, the point still holds at an earlier stage of education.

The two approaches to intelligence that have been outlined above show that there are possible differing conceptions of intelligence, and that these have been constructed for specific purposes, in this case, psychometric and educational. To the extent that they are designed for

different purposes, it is not clear that they should necessarily be considered _theoretical_ alternatives (although they might be _pragmatic_ ones, insofar as the process approach could be used for evaluation and selection).

Another, related, concept which we are about to turn to, is that of _cognition_. Traditionally it has been more or less equated with "intelligent" processes such as thinking, creating, problem solving etc., but more recently other apparently lower order components such as perception, attention and memory have been added. Flavell (1979) points out that there is good reason to cast the net of the concept more broadly rather than more narrowly; he cites the work of Fridja (1972) on theoretical models of long term memory. It seems that processes such as inferencing and strategies are implicated in this, and Fridja is at pains to point out that the distinction between remembering and problem solving is a gradual and imprecise one. Flavell (ibid) goes on to argue that many of the other processes implicate each other: the mind is a system which has richly interconnected parts, which are organised into a set of systems.

2.2 COGNITIVE DEVELOPMENT: PIAGET'S VIEW

2.2.1 General principles

The contribution of Piaget to our knowledge of cognitive development has been absolutely unique: his contribution to our knowledge of mind is on a par with that of Chomsky and Freud in the 20th century. However, his ideas about cognitive growth are often extremely complex and difficult to grasp, even when presented at length in an integrated whole. His ideas have been often distorted, oversimplified and generally misunderstood, especially when they are introduced into simplified summaries such as the one which is to be presented. However, we shall attempt to present the main aspects of his theory which we will need in order to compare and contrast his approach with that of other workers such as Pascual-Leone and Vygotsky. The description which follows is based on an account by an exponent of Piaget, i.e. Flavell (op cit, p.4 ff).

Piaget viewed human cognition as a specific form of biological adaptation of a complex organism to a complex environment. The cognitive system actively selects and interprets environmental information in the construction of its own knowledge. The mind builds its knowledge structures by taking external data and interpreting, transforming, and reorganizing them.

The cognitive system interacts with the world in adaptation. Cognition, like other forms of biological adaptation, exhibits two simultaneous and complementary aspects - assimilation and accommodation. _Assimilation_ essentially means interpreting or construing external objects and events

in terms of one's own presently available and favoured way of thinking about things: it refers to the process of adapting external stimuli to one's own mental structures. _Accommodation,_ on the other hand, refers to the converse or complementary process of adapting these mental structures to the structure of these same stimuli. In cognitive adaptations, we can say that the individuals simultaneously accommodate to the particular structures of the objects of their cognition and assimilate characteristics of those objects to their own cognitive structures.

The assimilation-accommodation model provides a general conception of the interaction between the cognitive system and the environment, but it is also a particularly useful tool for thinking about cognitive development, that is, about how the child's cognitive system might gradually evolve with maturation and experience. By repeated assimilation and accommodation to a given milieu, the cognitive system evolves slightly, which makes possible somewhat novel and different assimilations and accommodations, with these latter changes producing further small increments in mental growth. Thus the dialectal process of development proceeds in this gradual leg-over-leg fashion. Piaget's model makes childhood cognitive growth a logical outcome of repeated cognitive functioning, suggests that it should be slow and gradual, and allows for a considerable time for total developmental change, given a whole childhood in which to accumulate.

Piaget was concerned to explain the possibility of the development of logico-mathematical knowledge. His model for this was that of _equilibration,_ a concept invoked as a necessary process to account for the joint activity of assimilation and accommodation; the cognitive system has to be able to shift meaningfully and effectively from the one process to the other when there is disequilibrium, to produce equilibrium. There are three different kinds of equilibration: the most basic occurs when the subject acts on objects in the environment. The next mode emphasises the interactions between the knowledge gained from the actions on objects, and the last mode indicates the formation of a totality of knowledge about the world in which various bits of information are integrated, co-ordinated and ordered in relation to each other and to the whole (Craig, 1985, interpreting Piaget, 1977, p.3). The notion of equilibration is so central to Piaget's project that Craig (ibid) calls it an _intrinsic generative mechanism_ - i.e. a structure which is definitive in terms of the essence of cognitive development. The difficulty with the notion (to which we shall return) is in explaining what _causes_ the disequilibrium in the first place.

The notion of equilibration is called upon to explain transitions between distinct phases or stages which Piaget identifies in development. These are the sensori-motor stage, from 0 - 2 years, the preoperational stage, which lasts until about 7 years, the concrete operational stage which continues to about 12 years, and finally the stage of formal operations, which is supposed to start at about adolescence. The stages are epigenetic, i.e. each stage presupposes and builds on the previous one, being characterised by specific kinds of operations the child can engage in. The duration and sequence of stages is supposed to be invariant across different peoples. (There is more on this point in 2.5 below.)

Piaget's concern was for the epistemic (the "knowing") subject, the mind which is relatively independent of its social situation, although Piaget does acknowledge in principle that the social context is important in development. (We also look at social context below.)

2.2.2 Applications of Piagetian theory to education

Because Piagetian thought has been so powerful, there has been a nearly overwhelming temptation to try to apply his principles in different ways to education. This is largely an illegitimate exercise, since Piaget himself made it very clear that he was not a psychologist, let alone an educationist. Ginsburg (1985) has shown why there are limitations on what applications there should be.

In general terms Piagetian theory has limits in education because he has little to say about cultural knowledge, individual differences, the social context of education, and certain modes of learning in the class-room. As Ginsburg points out, education is more than the promotion of thought structures; rather, an adequate account of education will stress the transmission of cultural wisdom and basic social values. It is his stress on the biological origins of knowledge that led him to exclude certain modes of knowing (Piaget, 1971, p.268):

> We are omitting (from consideration) the modes of metaphysical and ideological knowledge because they are not kinds of knowledge in a strict sense but forms of wisdom or value co-ordinations, so that they represent a reflection of social life and cultural super-structures rather than any extension of biological adaptation. By this we do not mean to dispute their human importance; it simply means that the problems are quite different and are no longer the direct province of biological epistemology.

In principle then, we cannot ask a theory to account for issues that we are interested in on another account, but which it has specifically ex-cluded. Nevertheless, we should look at possible legitimate extrapo-lations from viable Piagetian concepts.

Firstly, one might ask whether we shouldn't derive our curriculum from the specific Piagetian stages: however, Piaget has stressed that these stages should develop spontaneously, and therefore there is little place for teaching. But the stage account does give us an indication of the parameters that will circumscribe what the child is able to do.

Secondly, in emphasising knowledge as active reconstruction, Piaget joined with educationists such as Dewey and Froebel. However, this prin-ciple has often been reduced to the notion that children should act on things. A careful reading of Piaget will reveal that he did not believe that this was so in more than a limited way in the earliest sensori-motor stage: rather, what he was focussing on was the notion of active engagement. And there is no doubt that this is required for effective problem solving. However, it can well be maintained that there is also

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place in the classroom for reception learning of particular kinds, such as learning phonics, and other mechanics of reading.

Thirdly, a very attractive learning principle resides in the relation-ship between cognitive conflict and equilibration. Learning is supposed to occur where there is a discrepancy between the child's cognitive structure and some new event he encounters. However, as we shall see be-low, equilibration theory is not fully developed. This interpretation probably confuses the notion of learning and development, where learning involves the accretion of structures, and development involves their transformation into higher order structures. However, in very general terms, if we can show the child that there is a discrepancy between what he knows, and what he is presented with, he may come to some change of his knowledge structures. At this level we need to have an account of expert teaching strategies, where the teacher knows what the children know, and how they know it and can challenge them in terms that are meaningful to them.

Fourthly, another attractive principle which has apparently fallen into line with child-centred educational theory is the self-directed learning of the child (cf. the School-Based Learning Experiences Final Report for further description of this point); however, while Piaget would allow that the child is engaged in the active construction of his own know-ledge, this does not mean, that over the whole spectrum of school activ-ities, the child will choose those that maximize his own cognitive growth. Apart from the fact that affective and motivational variables come into play here, there are types of learning that will need to be imposed in a receptive-rote way first, before they take on their own generative power; a particularly apt example here is learning to play a musical instrument.

In order to account for school learning in toto , one needs a more gen-eral principle of learning, which could cover logico-mathematical learn-ing as well as more general modes of learning. The common denominator would seem to be meaningful learning which (according to Ausubel, 1985) takes place if the learning task can be related in a non-arbitrary, sub-stantive (non-verbatim) fashion to what the learner already knows. So, while we accept Piaget's account of the construction of scientific know-ledge, we can see the need for a co-ordination with a theory or theories that give account of the learner's cultural-social learning task as well.

In summary then, we can take with us further the notions of qualitative changes in the nature of thinking, knowledge building as active recon-struction, the potential self-directedness of learning, and the need for an account of social and cultural adaptation.

2.3 THE INFORMATION PROCESSING SYSTEMS (IPS) APPROACHES TO DEVELOPMENT

In the 1970 edition of the Handbook of Child Psychology, there were only two references to information processing systems (IPS) approaches. In

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the fourth edition of the handbook, thirteen years later, it has a major section devoted to it, and Siegler (1983) argues that it is the leading strategy for the study of cognitive development.

Siegler (ibid) cites four reasons for the appeal of these approaches. Firstly, there is their general perspective on human beings. On this account, people are in essence limited capacity manipulators of symbols. The symbol manipulation takes place on multiple levels: we organise elementary information processes into hierarchies of goals and subgoals.

However, a variety of processing limitations can prevent people from attaining their goals:

*limitations on the number of symbols they can manipulate simultaneously;

*limitations on the speed with which they can manipulate symbols, and

*limitations on memory search.

To overcome these processing limitations, people use a variety of strategies:

*mnemonic strategies such as rehearsal, elaboration and organisation can augment short-term memory;

*external memory aids such as books can combine information from many sources to overcome limitations of the knowledge base;

*problem-solving strategies such as means-end analysis can overcome limitations in connection with decision making.

As Siegler (ibid, p.129) puts it:

The tensions among the setting of goals, the processing limitations that hinder their attainment, and the strategies developed to overcome the processing limitations create an appealing, even dramatic, metaphor for mankind's efforts to know the world.

The second reason for the appeal of the IPS approaches is the usefulness of their languages for characterising cognition. General notions such as scripts and frames provide means for describing the ways in which knowledge might be organised. More tangible representations such as flow diagrams and decision trees are valuable for representing hypotheses about the temporal nature of cognition.

The third reason for the appeal of the IPS approaches lies in their powerful methods, for example, protocol analyses which rely on people's verbalizations to indicate the strategies which they used to solve problems, and error analyses that emphasise patterns of correct answers to reveal children's conceptual understanding. The different methods of the IPS have common characteristics: they are oriented towards testing models, rather than indicating variables; they use a rich data base, and

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the pattern of the data is of the greater importance, rather than the percentage of correct answers or the absolute speed of performance.

One of the compelling reasons why we should pay attention to the IPS approaches is that they have addressed in detail areas of crucial interest to our project, namely the processes of reading and writing. Reading offers a rich target for theoretical analyses: it illustrates the multiple levels at which information processing analyses can be performed on a single task, and the complexity of allocating processing resources among competing demands. We pay special attention to the analysis of metacognition and reading in section 3.5 below. Writing is a topic which has been most comprehensively addressed by Bereiter and Scardamalia (we refer to a number of their studies in 3.4.2 (b) below). They have addressed the issues of why initial expository writing is difficult, why revisions are often no better than the originals, and how writing skills can be taught.

Of particular interest to the IPS is the representation of information, e.g. do people think in language or symbols, or rather some amodal form? Are mental representations serial or in parallel? Is there a difference between knowing how and knowing that? One kind of representation that is used is a semantic network, which is an interconnected set of propositions. (Propositions are the simplest entities that have truth values.) Ordinary verbal statements often have several propositions; for example, the sentence *The fox jumped over the dog* can be decomposed as follows:

1. There was a fox.

2. The fox jumped over something.

3. The something that was jumped over was a dog.

A semantic network representation of the sentence would include each of these propositions.

Another kind of representation we could call, generically, scripts: scripts, plans, frames, schemata, and story grammars are attempts to capture knowledge of a more amorphous kind than would normally be represented in a semantic network.

Schank (1975) defined scripts as predetermined sequences of actions that characterize situations. They might be thought of as "the way things usually go". They include information about the obligatory events and actors, about the range of situations in which the script might apply, about the actors' purposes, and about distinctions between specific scripts and related ones.

A third kind of representation involves what are called production systems. A production system can be thought of as a five-level hierarchy. The production system divides into the production system proper and short-term memory. The production system proper is made up of individual productions. Each production has a condition side and an action side. The condition side of the production, the action side of the pro-

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ductions, and the short-term memory are all composed of symbols. A match between the symbols in short-term memory and all of the symbols on the condition side of a production indicates that the production is relevant to the immediate situation. If a production fires, the actions on the right hand of its arrow are executed. A schematic model of a production system is reproduced at Figure 2.1.

Semantic networks, scripts and productions systems differ on a number of dimensions, so it is reasonable to ask in which domain each one could be used most profitably. Anderson (1976) suggested that the type of knowledge being represented should be the decisive factor. Semantic networks are most useful for modelling declarative knowledge - facts about the world, which should have many access routes. Semantic networks afford such varied access, since all concepts are linked to all other concepts. Models of long term memory, which to date have been concerned primarily with declarative knowledge, therefore have found semantic networks a convenient representational model. (But cf. the comment at 2.1 that inferencing and strategies also need to be accounted for in this context.)
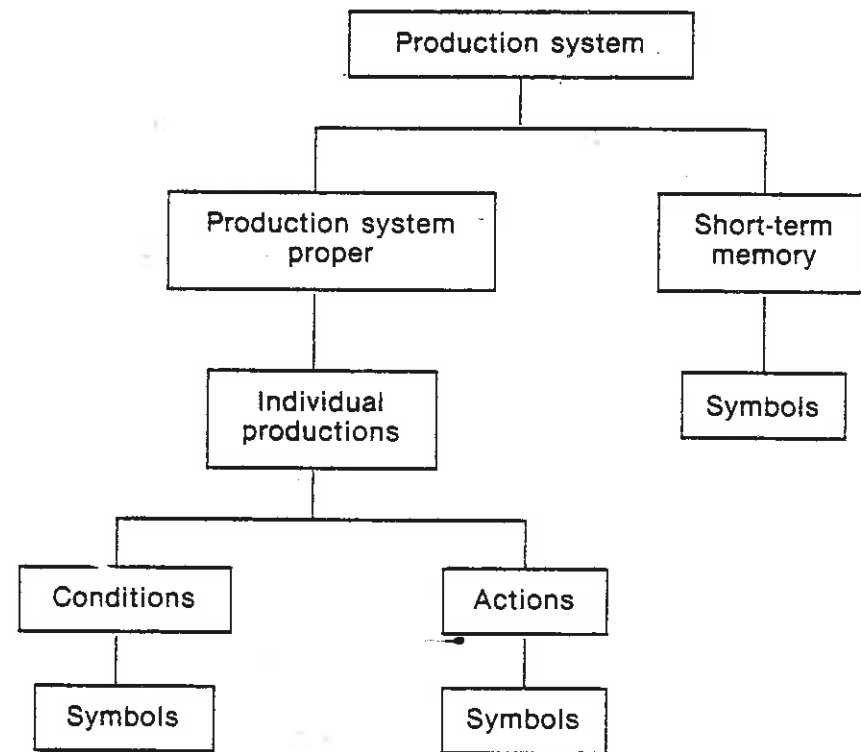
Figure 2.1 A schematic model of a production system (Siegel, 1983)

Production systems also can be used to model declarative knowledge, but more often have been used to model *procedural knowledge* - knowledge about how to play the piano, ski, look at paintings, etc. People do not seem to have multiple, easy access paths to the components of such knowledge (try for example to recall what note comes after the second D in

our National Anthem). On the other hand, they do possess smooth and rapidly executable performance routines (it is not difficult to find the note on the piano). In representing procedural knowledge, then, efficient execution seems more important than multiple access routes. Production systems, which place unique conditions on when each production will fire, seem compatible with this demand. However, procedural knowledge will interact with declarative knowledge when we apply cognitive skills or strategies to our knowledge base.

Both semantic networks and production systems model knowledge at a relatively specific level: scripts, on the other hand, seem most useful for representing event sequences at a more general level. They and the related formalism of frames, plans, schemata, and story grammars, have most often been used to characterize situations in which procedural and declarative knowledge are both necessary.

2.3.1 The developing IPS : the issue of what develops

Many researchers have speculated that many basic processes and representational skills are innate (e.g. Simon, 1972). The speculation is not just simple-minded hopefulness, because it is not clear how a cognitive system can develop a basic process that is not present early on. For example, how can a person learn to retrieve facts from long term memory if retrieval is not a biologically given capability? On the other hand, one could imagine that experience of learning could assist with the speed and efficiency of such processes.

The basic information processes which seem to be present from early in life would include recognition, visual scanning, categorical perception (organizing perceptual events into features), learning , and intersensory integration. There has also been a great deal of speculation about short-term memory (STM) capacity. Pascual-Leone (1970) has suggested that the number of slots in working memory increases with age. Manis, Keating and Morrison (1980) suggested that attention is allocated more efficiently with age. Wickens (1974) and Miller (1969) suggested that speed of information processing increases with age. Siegler (1983) observes that it is difficult to distinguish these theories operationally from each other, and it is unclear how we would determine whether central processing capacity is a set of discontinuous slots, a continuous resource that can be allocated, or a limited speed of symbol manipulation.

Siegler (ibid) finds another difficulty in interpreting the literature: there are those who say that there is a developmental increase in capacity, and those that say developmental changes are a function of increased knowledge or improved strategies. Research evidence that is cited in Siegler's review often confounds the two. We will see below that this is an important distinction, because if we assume that basic capacity is a function of age, and we can possibly assume the

malleability of strategic learning (cf. 2.4 below), then we have the foundations of a culture free account of development.

To look at *strategies* themselves: there are four that have had examined in developmental research, i.e. rehearsal, semantic organisation, elaboration, and allocation of study time. Siegler observes that one of the best replicated findings in developmental psychology is that children below five or six year are less likely than older people to rehearse materials which they are trying to memorise; and it doesn't always help to instruct young children in rehearsal strategies, because they forget to use them, or fail to transfer them to new situations (cf. for example, Hagen, Hargrove and Ross, 1973).

Younger and older children also differ in the quality of their semantic organisations. Young children tend to use similarity or associative strength as the basis for their organisations; older children and adults more often rely on taxonomic relatedness (Flavell, 1970). It seems that efforts to teach children organisational strategies have yielded similar results to efforts to teach them rehearsal strategies.

Elaboration, the third most frequently studied memory strategy, refers to the imposition of semantic connections in situations where no obvious relations exist (for example, on a mental shopping list, where chutney, toilet paper and lipstick might be required). Younger children are less likely than older children to generate effective elaborations, and are more susceptible to elaborations that might be suggested by the experimenter (e.g. Reese, 1977), (cf. the section below on Vygotsky).

The fourth strategy that Siegler reviews is the allocation of study time: by this is meant the kind of time the child will decide to devote to aspects of a memorisation task. As we might have predicted (cf. Flavell, Friederichs and Hoyt, 1970) older children i.e. closer to ten years, spend more time "studying" on a task than do younger ones, and they engage in a greater variety of subsidiary strategies, for example, naming objects, rehearsing them, and testing themselves.

Several trends emerge from Siegler's review of the contributions of memorial strategies to the development of the IPS. The use of such strategies becomes more frequent with age, particularly between the ages of five and ten years, and children adjust their strategies with increasing fineness to task demands. Children who use strategies remember more than those who do not. Clearly, it is very important to be active in trying to remember, but it does not always help to try to teach these strategies. It has been suggested (cf. Flavell and Wellman, 1977) that an understanding of one's own memory processes - metamemory - might influence the maintenance and generalisation of such strategies. But, we should like to add, that understanding the nature of something does not automatically render it more usable (cf. our discussion in Chapter Three on developing strategies for self-evaluation in expository writing).

Before we turn to look at a particularly salient aspect of IPS type research, i.e. metacognition, we look finally at the mechanisms of development proposed within this framework. One traditional approach is to emphasise the system's capacity for *self-modification* (cf. Piaget's as-

similation and accommodation). This can be considered in the framework of production systems: productions can be designed to build new productions based on the systems performance, so the system simultaneously performs and develops. Klahr and Wallace (1976) have sketched mechanisms by which a self-modifying production system might operate. The time line - a temporally ordered record within which people preserve their goals, STM contents, and outcomes - provides the data used by the self-modifying productions. Two mechanisms that operate on this data base are *consistency detection* and *redundancy elimination*. In other words, we find that there are higher order mechanisms that serve to evaluate the system. However, there does not appear to be any work that has attempted to model the stage-like transitions of the Piagetian model. We do not know sufficient about this type of modelling to see its furthest implications. However, we would surmise that attempts to model self-modification would be well founded if one assumes that self-modification is a sound mechanism of change.

Another candidate as a mechanism for change is *automatisation*. Case (1978) has developed a stage-dependent theory that seems in some ways to be an IPS interpretation of Piagetian notions. For example, there are four stages, which are defined informally in terms of conditions and actions. Case proposes that the development within each stage depends on the functional size of the working memory. The underlying capacity of working memory is said to be constant from an early age, but the functional capacity increases in the automaticity with which operations are executed on the contents characteristic of each stage. As each operation is executed more efficiently, working memory space is freed for additional operations. However, Case does not actually give an account of how automatisation increases functional capacity, so we are left with a label rather than a construct. This does not however, mean that automatisation does not have potential explanatory value for accounting for development.

Two other constraints on conceptual development that have been advanced are *encoding* and *combining*. Encoding is the process by which incoming information is segmented and abstracted to build a representation. If the units are not at a useful level of abstraction, or if important information is excluded, conceptual development is hindered (Siegler, ibid, p.197). Combination subsumes at least two subprocesses: choosing features for inclusion in concepts, and integrating features into performance rules. Encoding interacts with combination in the first of these: if useful features are not encoded, they cannot be chosen for inclusion into rules. Even if useful features are encoded, however, the two combination processes still must be executed. People must choose from among the features they encode which to include in the concept; they must also establish relations among the features they do include in the concept (Siegler, ibid, p.199). Once again, we have more in the line of description rather than explication of these mechanisms. To our mind, encoding and combination look like good candidates for basic cognitive processes, but it seems likely that they themselves may undergo some developmental change. In other words the segmentation of information may undergo a qualitative change, as might the nature of the features in combining.

In general the IPS approaches fail to account adequately for the qualitative development of cognitive processes; a specialist version described below at 2.4 is more adequate to the challenge. However, this theory has to invoke a two-level set of cognitive operators to solve what in essence is a rationalist problem.

2.3.2 Metacognition as a theoretical construct

Experts know more about their areas of expertise than do novices. However, there are some other interesting differences as well: experts not only know more, they know that they know more, they know better how to organise what they know, and what they know is better organised and readily accessible, and they know better how to learn more still (Nickerson et al, ibid).

However, there is a difference between having some information in one's head and being able to access it when needed, and between having a skill and knowing when to apply it. All these "knowing about knowing" concepts have recently become to be explored under the rubric of *metacognition,* including metacognitive knowledge, experience and skills.

The concept of metacognition has become increasingly popular over the last decade, and in many cases it has become "fuzzy" - covering too many, possibly distinct, attributions. To restrict ourselves to the most orthodox meanings will give us a clear sense of direction, and here it is safe to stay with Flavell (1976, 1979, 1981), who was one of the originators of the term.

> Metacognition refers to one's knowledge concerning one's own cognitive processes and products or anything else related to them, e.g. the learning-relevant properties of information or data (1976, p.232).

> Metacognitive knowledge consists primarily of knowledge or beliefs about what factors or variables act and interact in what ways to effect the course or outcome of cognitive enterprises (1979, p.907).

Firstly, metacognition is essentially cognition about cognition. Insofar as cognition involves perception, understanding, remembering, etc., so metacognition would be the superordinate terms for "metaperception", "metacomprehension", "metamemory" and the rest. Metacognition can be differentiated into metacognitive knowledge and metacognitive experience, and one can distinguish between metacognitive and cognitive strategies.

Metacognitive *knowledge* is relatively stable, usually information about cognition (Baker and Brown, 1984). This knowledge is about *ourselves,* the *tasks* we face, and the *strategies* which we employ. We know about ourselves such things as about what tasks <u>we</u> find difficult, and what

kinds of tasks everybody finds difficult. About tasks, we may know something about their relative difficulty (e.g. it's more difficult to read one's general science textbook than one's English reader). About strategies, we may know something like the following: verbal rehearsal and elaboration of material assists in retrieval - as children discover (cf. the previous section). It seems as though children will learn to acquire information of this kind through abstraction of regularities in their cognitive processing over time (Flavell and Wellman, op cit), although it is very possible that they will learn it in the culture of the school. However, we do not know what the pupils we studied know about strategies, although we did watch them use some, for example, when solving word problems. When invited to do so, they would draw representations of the simple mathematical sums (we shall describe this research below in section 2.3.3).

One can of course use information about person, tasks and strategies simultaneously. Flavell (1985) would claim that metacognitive knowledge is not different from other knowledge. If it is indeed like other kinds of knowledge, then it may be accessed intentionally or automatically, may be made more or less conscious, and may be influential with or without entering consciousness. The issue of consciousness is one with which IPS specialists do not necessarily feel very comfortable with: it may summon up an image of an homunculus directing the operations of the IPS. We will see below that IPS specialists have a slightly different conception than Piagetians do (such as Flavell) of the process of "metacognition".

Metacognitive knowledge serves as a base for metacognitive experiences. For example, one may realise that one is able to perform a task of a specific kind (e.g. filling in the blanks of a cloze exercise), and one may choose to use a strategy to facilitate the process. Metacognitive experiences may occur when cognitions fail. For example, although the child may not think explicitly "I do not understand", a sense of confusion may lead him to try a different strategy. Of course an unsatisfactory situation occurs when cognitive failure goes undetected: this is when one does not know that one does not know. Apparently this is a pervasive problem in comprehension monitoring (Garner, 1987 cites four reviews), and we report below on Markman's (1979, 1981, 1985) research, which has a bearing on the problem area of our project.

However, the perception of cognitive failure may lead to strategy use. The actual use of strategies involves cognition, whereas the monitoring of these strategies involves metacognition. There are three components in the use of strategies - the skills themselves, knowing when to use them, and also the motivation to use them. Obviously these factors will vary across learners (cf. the section above).

From a pedagogic point of view, assuming (as we do) that cognition strategies can be taught, it would be important to identify -

1. specific skills that are age-appropriate,

2. ways of inculcating these skills in different contexts,

3. ways of cueing pupils when to use them, and

4. ways of convincing pupils that using them will result in more effective learning.

See Chapter Four for further detailed discussion of educational implications.

The paradigmatic conception of the relationship between metacognitive components is that given certain cognitive goals, metacognitive knowledge is a basis of metacognitive experiences which in turn prompt the use of cognitive and metacognitive strategies. However, many other possible interrelationships exist, where one moves in and out of the different components, during problem-solving, for example.

In the IPS literature, there is an emphasis on *executive control,* which roughly speaking, approximates to the interrelations between metacognitive experiences and strategy use. So, on the one hand (with Flavell), one might talk about fostering introspection and metacognitive experiences, and on the other hand one could talk of "self-control" training.

Both the Piagetians and the IPS specialists would be interested in learner strategies, but from a different perspective. For developmental psychologist, strategies form part of the metacognitive picture (as we have seen from Flavell, above). In contrast, many information processing theorists place strategic processing or "executive control" at the heart of cognitive activity. The control processes make for efficient use of the limited-capacity processing system. This set of processes directs the activities at each processing stage and makes certain that the system functions as a whole through the many processing steps. Brown (1977, p.4) stresses that part of development is a gradual increase in the control of cognitive processing: "in the domain of deliberate learning and problem solving situations, conscious executive control of the routines available to the system is the essence of intelligent activity"

One of the most productive applications of research in the area of metacognition is in the field of reading research. We consider this research so important, and of such potential value, that we devote a section to it in Chapter 3 below. However, before we pass on to the next section, it is well worthwhile to briefly consider work that has been done on comprehension monitoring, which would be part of metacognitive experience, and which has relevance to both children's listening and reading skills.

Firstly, it seems that children are less critical monitors than we would suppose them to be (cf. Markman's review, 1981). Our interpretation of this finding would be that in naturalistic situations, children might pay less attention to natural language processing, than the rather more rigorous attention required of them by cognitive developmentalists who give children highly structured, but "bare" tasks (i.e. lacking in intrinsic interest or everyday relevance). It seems (Markman, 1979) that children seem to focus on sentence interpretation rather than logical inference across discourse. Our own impression from observing even the

most animated discussion in a class of mother tongue speaking (English) Standard 3 children, the nature of the discourse seems to be loosely associative rather than strictly logical; the teacher "marks" the problems in the subject matter by the way that she talks about them. It seems as though there is a tacit presuppositional agreement between the teacher and the class that the discourse is going to be logical and coherent (within developmental constraints of course), so this is not usually what is at issue: usually what the children know *about* a topic is at issue. In contrast, in the black junior primary classroom it would not be unfair to say that what is at issue is what the children are going to learn about a topic, and the teacher structured input may be markedly lacking in explicit indicators of coherence.

Secondly, children are also surprisingly less likely to explicitly report noticing an inconsistency than their nonverbal behavioral indicators would lead us to expect. (So, for example, they will reread ambiguous or inconsistent statements, but not comment on them). In the black primary classroom it would be highly inappropriate for a child to comment on an inconsistency, since this would cast aspersions on teacher-controlled discourse. Capelli and Markman (1982) interpret the finding on inconsistency as young children having a high threshold level for reporting incomprehension. This makes sense to the extent that if young children are having a difficult time following something, they are only going to make their own task harder, by interrupting their comprehension processes with higher level metaprocesses. Alternatively we might say that all their cognitive space is occupied with first level processes of comprehension.

Thirdly, it seems clear that children are more likely to suppose adults' discourse is correct or accurate than their peers (Sonnenschein & Whitehurst, 1980). We would see this finding holding even more strongly in an authoritarian based education system, and therefore it is very important that adults should be accurate models.

Fourthly, Markman (1981) has noted the effect of poor reading skills on comprehension monitoring. Poor readers will struggle to extract meaning, getting a choppy segmented version of the text, let alone check their comprehension. How then do we get to a position that children can monitor that which they are reading? In terms of the review which has been presented in this and the previous section, we would hypothesize that it may not be effective to try to deliberately teach comprehension monitoring. Rather, what the teacher should first focus on is teaching the children to actively comprehend. Then for example, the teacher could set up practice drawing inferences and formulating expectations.

Markman (1985) says that comprehension will be limited if:

* the reader is rigidly bound to the superficial form of the material,
* he is unable to paraphrase it, and
* he is unable to move beyond it.

If indeed these conditions generally obtain, then they constitute the most daunting of constraints for genuine learning through reading in the

second language. However, we need to know what the child can do in the first language by the age of ten years, before we start creating unduly high expectations on the second language learner. Specifically, we suspect that first language Standard 3 learners might be said to have limited comprehension using these criteria. The apparently limited comprehension (eg using the language of the text) might arise as children start to penetrate subject-specialist terrain beyond their immediate ken. However, a further test of comprehension would be the application of new acquired knowledge structures to new situations in extension activities.

2.3.3 Research on strategies and metacognitive knowledge on the Threshold Project

The research which is reported in this section was actually conducted after the research reported below at 2.7. However, our thinking on the project moved to metacognition when we thought about styles of teaching and styles of learning in 1987. We found that there was local thinking about the relationship between executive processes (i.e. goal directed strategies of approach in problem solving) and culture. Verster (1986, p.15) of the National Institute of Personnel Research has this to say:

Although it is possible that certain executive processes may be innate (Carroll, 1976), in most cases they are likely to arise through learning, whether formal or informal, and to become entrenched through *culturally mediated habits in thinking*. Executive processes then, which are essentially goal-directed strategies of approach in problem solving and thinking, are a major locus for cultural influences on cognitive development and performance. At least some, if not most, executive processes may be culturally relative and hence not represented in all populations.

We carried out two small-scale cross-cultural studies during the course of 1987, called *Building Stories* and *Doing Story Sums*. We will discuss each of these in turn.

A. Building stories

In this study we tested 20 Standard 3 children from a Primary Education Upgrading Project (PEUP) school in the local Moretele circuit, and 34 children from two multi-cultural church (MC) schools. The PEUP children were tested in Setswana, and the MC children in English. The task comprised four sets of cards which had to be ordered into stories. Only one coherent ordering per set was possible e.g.

1. The principal punished them for fighting

2. They were taken to the office

3. The boys were playing marbles

4. They started to fight and hit each other in the face

There were two aspects of the children's performance that we were interested in. Firstly, whether they could order the cards correctly, i.e. whether they could solve a simple discourse problem, and secondly, what kinds of justifications they gave for their orderings, in other words, what sort of monitoring they could articulate.

We had expected that all children by Standard 3 could order the cards correctly, but this was not the case. Only two-thirds of the time could the PEUP children order the cards without some sort of prompt. However, the majority of the time (95%) they could order the stories eventually. The fact that they often needed help with ordering, may have diverted their mental energy away from thinking of reasons for their ordering.

We had fully expected the children to give justifications that had reference to discourse cohesion cues (e.g. "the boys first, then they"), but these cues might as well not have existed for all the notice the children took of them. On the contrary, the most sophisticated reasons were given in the form of pragmatic inferences (e.g. "they had to have been doing something bad to go to the principal's office"). What appeared to us to be lower order kinds of justifications occurred when children simply related the story again in the correct order, or told us that "it makes sense." We found that we could provoke "logical" (pragmatic inference) responses when children did not offer them spontaneously. However provoking them on one occasion did not seem to provide a sufficient impetus for the children to spontaneously use this justification on the next item (cf. Siegler's (1973) review above on strategies being resistant to training).

There were rather different response patterns across the two groups. Firstly, the PEUP children were twice as likely as the MC children to give the rather opaque justification, "it makes sense". Conversely, the MC children were twice as likely as the PEUP children to make pragmatic justifications.

The PEUP children are very seldom exposed to tasks like this, and they seemed to enjoy the physical manipulation of the beautifully drawn cards with the printed sentences. On reflection, we realise that if the children had been exposed to repeated trials of the same kind of task the salient learning effect on task ordering would have been reduced. However, it seemed to us that they would not be commonly asked to reflect and comment on a counter-intuitive state of affairs such as when we tried to provoke a logical-pragmatic justification. It seemed to them to be sufficient that they had now made the story make sense.

B. Doing story sums

In this study we used 19 Standard 3 children from a PEUP school, and 23 from an MC school. The PEUP children were tested in Setswana, and the others in English.

The purpose of the study was to ascertain whether children could give us a report on their cognitive processes after doing story sums. We tried to choose very simple problems so that the children could give us some reason for the operations they chose and the answer they gave. The presupposition turned out to be misplaced. The arithmetical operations required were not beyond that required by Standard 1, as for example in

Mother likes to bake. She bought 15 eggs. She used 3 of them to bake a cake and scrambled 3 of them. How many did she have left? She also had a litre of milk,

but many PEUP children were not able to perform them. For example, one-fifth of the time they made simple mechanical mistakes, and one-quarter of the time they used the incorrect operations (e.g. adding instead of multiplying for example). In contrast, in the MC group, the children never made mechanical mistakes, and only one child once chose the incorrect operation. The PEUP children were also sometimes misled by the distractors (irrelevant information) which had been deliberately placed in the sum. The net effect of all this misdirected mathematical effort was that the children did not seem able to give us explanations of why they had done what they had done. It should be pointed out that these testing sessions turned into impromptu tutorials, in which we taught children how to approach easy word problems: however, with increased competence did not come increased insight. The predominant strategy of those children who tried to give justifications for what they had done was simply to read the story again. (Note the way the task remains "un-analysed" at some level, like the stories did in the previous task). The MC children also did this, but they spent an equal proportion of their time stressing the key words in the story sum that indexed the oper-ations to be used, and also explaining what operations were to be used, often by contrast to what would not work (for example, one has to multi-ply, because division would give entirely the wrong answer). In this final type of justification, it seemed that the children did not strictly link up the words with what they had done arithmetically: the doing of word sums had become automatised at some level. The children were genuinely able to transform the problems into a different, logical system. One of the MC teachers said that her children were past doing stylised questions (as were the task ones), and were currently engaged in more real world problems.

In this study it was difficult to separate out the effects of what was genuine ineptitude with simple mechanics of mathematics, which was deeply disconcerting as a finding, with a failure to relate the oper-ations of real life with the operations of mathematics. At this stage in the curriculum, mathematics can still be related at every point to understandable activities of life (e.g. giving away equally = division or repeated subtraction), and yet it seemed not to make any real con-nections for the children. We wondered whether the children at the PEUP school were learning mathematics as a scarcely understood, mysterious system, disconnected from their other experience, rather than making a genuine progression from the concrete to the abstract. In the more limi-ted perspective of the particular task it seemed that children were not able to make conscious and explain the mathematical strategies they are using. Further research is indicated on whether black teachers are able

to communicate the connections between real life transactions and math-ematical processes which can represent them.

These two studies were conducted without a very tight theoretical base, although they could well be accommodated under the rubric of metacognition. While we are not able to give an account of the results in strict IPS terms, it did become clear to us that genuine differences exist between the two samples of children tested. It seemed as though we were posing a real challenge simply in the form of the tasks for the PEUP children, and certainly the idea of giving reasons for your answer seemed to be entirely novel. What is not clear to us at this stage is the implications for the child in his school career of what appears to us to be an inability to bring to awareness control processes. However at this stage there would already be grave consequences for children not having strategies for estimating answers and for checking one's oper-ations. More than a mechanical understanding is required here. How-ever, the discussion in this chapter on indigenous mediational operators (2.6.3) and in the next chapter on knowledge telling (3.4.2) may bring us further clarity.

2.4 COGNITIVE DEVELOPMENT: THE THEORY OF CONSTRUCTIVE OPERATORS

The Theory of Constructive Operators, developed by Pascual-Leone (1970), is essentially a neo-Piagetian theory of regulatory or constructive op-erators, which uses a blend of Piagetian and information processing con-cepts.

The immediate value of the TCO is seen in its account of equilibration. Pascual-Leone has pointed out that Piaget's concept is a structural de-scriptive one, and that an adequate psychological theory ought to have a process-structural account, to explain exactly how development occurs.

He explicates Piaget's notion in terms of the organism's need to undergo structural changes. This need is conceived of in order to (a) maximise consistency amongst the functional parts, (b) maximise functional payoff in its dealing with the environment, and (c) minimise internal complex-ity. The first principle would be dealt with using the standard Piagetian notion of adaptation. In the TCO, the next two subprinciples are dealt with by two new concepts : the *silent operators* and the *sub-jective operators* of the so-called metasubject.

The two kinds of operators mentioned above are dealt with at two differ-ent levels, for very specific reasons. The central principle of *bilevel* psychological organisation is a conceptual move towards the explanation of why particular schemes apply rather than others in a specific situ-ation. This principle also helps to account for the so-called learning paradox: that is, how can we do something completely novel that we have never executed before? We need to have a way of explaining this without invoking the concept of experience, and Pascuale-Leone postulates organismic factors different from learning. These metaconstructs of si-

lent operators are responsible for the "choice" among schemes. In other words, Pascual-Leone attributes more structure to psychological machinery than Piaget has done.

We shall now present a technical account of the two levels of psychological organisation. While it is not important to have a grasp of all the details, an overall impression is important, because several of these constructs are referred to again in the course of the report.

The subjective operators refer to content-specific schemes (semantic-pragmatic units), which in turn are operated on by the silent, content-free operators. The content specific schemes have referents, and carry the notions of truth and causation, together perhaps with possibility (my own interpretation).

At the next level are the silent operators: there are seven of them, listed below, of which we will briefly discuss two:

* M – operator (mental capacity)
* L – operators (two kinds of learning)
* F – operator (to make closure)
* I – operator (for centration and decentration)
* A – operator (affect)
* B – operator (biases and beliefs)

Recall the important point to be made here is that it is necessary to invoke two levels of functioning to account for intelligent performance; and as we shall see, we will also be able to account for the difference between development and learning.

The M-operator is the primary developmental construct; equilibration can be explained in terms of an increase in M-power. It refers to the reserve of mental energy allocated to raise the activation weight of the task-selected schemes. The M-operator can be used as a predictor of performance insofar as the M-demands of the task can be metasubjectively analysed. This is useful developmentally since its capacity increases in terms of age, in terms of the number of schemes it can boost. (Other workers have referred to a similar phenomenon i.e. the age-bound limits on mental effort and working memory.) The M-operator has two components, e and k. The component e – refers to the M-capacity used to activate general task situations and instructions, an executive function which seems to remain relatively constant after the sensori-motor period. The component k – refers to the specific schemes that can be M-boosted in any centration act. The number of schemes that can be so boosted appears to increase by an integer of one every second year.

Pascuale-Leone worked out the relationship between $e + k$ very precisely in relation to the Piagetian stages, and details of this may serve to concretise the notions for the reader:

$e + 2$: preoperational stage –   5 to 6 years
$e + 3$: low concrete operational stage –   7 to 8 years
$e + 4$: high concrete operational stage –   9 to 10 years
$e + 5$: introductory formal operational stage – 11 to 12 years

However, the application of M (attentional energy) is a function of the executive schemes that mobilise it. Executives are learned in individual experience in situations of certain (experience learning) sorts. In effect this leads to the need for the distinction between structural and functional M. Structural M refers to the absolute capacity which is available to the thinker, whereas functional M refers to the capacity that is used on a particular occasion. $M(f)$ is affected by cognitive style and personality characteristics, which seem to parallel the effects of executive routines (for example, not allowing maximum boosting of schemes).

The L-operator is the force that is applied to control performance in conformity with learned L-structures in question, when particular well-learned sets of schemes are activated. In contrast, it is M that makes it possible to attend to new non-salient aspects of a situation. Hence M is the determining constraint in development.

There are two types of learning – content and logical learning. Content learning accounts for those aspects such as trial and error, skill practising, and experiential learning. In logical learning, relations of co-activation exist between schemes: there are two subtypes here. One subtype of logical learning occurs when there is chunking of information (and when information is chunked, it is regarded as one unit for the purpose of the $e+k$ equation). The other subtype of logical learning is associated with the M-capacity and it is associated with the creation of temporal task executives, which are plans, or general ways to proceed. The capacity to develop these will increase developmentally, with age.

Miller, Pascual-Leone, Campbell and Juckes (1985) would claim that the TCO is ideally suited for cross cultural research. They say that the theory has two merits that warrant attention. The first is that the theory has the potential to explain both similarities (i.e. by looking at M-capacity) and differences (i.e. by looking at the different effects of the L- operator). The second merit that Miller et al draw attention to is that the constructs can be tested empirically using relatively simple and unusually precise quantitative measures, for example, the Compound Stimulus Visual Information Task (CSVI) and the Figural Inter-sections Test (FIT). In fact the first task has been used twice in the South African context, once by Miller et al and the other time by Juckes (1987), and the second (FIT) task once (by Miller et al).

In the first CSVI test, it was found that township Zulu children showed the same k values as middle class Canadian children. However, in the second experiment by Juckes in another Zulu township, it was found that the children showed poor arousal executives and therefore did not use their full $M(s)$. (Remember effects such as cognitive style are supposed to affect the full use of the structural M.) Nevertheless, Miller et al feel that the M-construct may actually provide the sought after culture free or culture fair quantitative measure of developmental intelligence. This is an important point to which we shall return.

The FIT test is able to separate out the effects of development (M- operator) and learning (L-operator) factors. The researchers had established the children's M-power independently by using the CSVI, so when

they tested the M-power initially on the FIT, the poor performance of the children was attributed to extrinsic factors. Repeated trials on the FIT showed that the children, who were not trained, were able to learn from the situation itself, and construct more efficient means of executing the task. In other words "the subjects were able to draw on some learning resource or internal mechanism that allows them to produce task relevant executives" (p.41 op cit).

At least as interesting as the details of the two TCO tasks is the argument which Miller et al adduce for the necessary universality of aspects of intelligence. If we accept that culture is a product of human creativity, and that human beings are able to successfully perform in unfamiliar or novel situations,[2] then the mechanisms of intelligent performance (rather than the performances themselves), may be, and in all likelihood are, invariant across cultures. To say this is not to deny that there are context specific effects of learning, which will lead to (manifest) performance differences: and of course these differences are of interest in trying to analyse the difficulties of an emerging educational system (and indeed these will be addressed below).

It seems that Miller et al are concerned in this instance to show how a highly cohesive psychological theory can give good reason to resist prejudice. They conclude their study (p.45):

The best insurance against cultural, ethnic or racial prejudice is evidence that the apparent diversity of human expression is governed by psychological processes that are demonstrably universal.

(Notice however, that their research did not in fact demonstrate any kind of universality: it was a comparison of two samples. Rather, they argue for universality in terms of necessity.)

The issues of mind and culture have been very carefully steered away from in the South African context, because of the possibility that research, however cogently presented, could be fed into a system that perverts its meaning to justify repressive policies. In discussing this, Miller (1984) notes that even Luria (1976), who pioneered the study of questions relating mental processes to sociocultural forms, was aware of the possible use it could be put to in justifying inequities. To this extent, the cross-cultural cognitive research conducted in the 1980's has been a brave initiative in the face of the possible difficulties that it could have, and might still, encounter.

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2   The issue of novelty or change is an axis around which much of cross-cultural psychological argument revolves. Neither the hereditarian nor the relativist positions are able to account for the fact that people are able to cope with novelty, to transform the unknown into the known and familiar: this must be a universal principle of human cognition.

2.5 CROSS-CULTURAL COGNITIVE PSYCHOLOGY

2.5.1 The hereditarians and the cultural relativists·

In trying to analyse the relationship between mind and culture, two main positions have been taken. The first, taken by people like Jensen and Arthur (1972) and Eysenck (1971) holds that intelligence is largely accounted for genetically, and that very little variance can be accounted for by environmental influences. Specifically, performance on IQ tests is largely a function of genetics. The manifest performance differences of different social and cultural groups are evident, and one response to this is to try to build culture-free or culture-fair tests.

On the other hand, the cultural relativists (cf. the Laboratory of Comparative Human Cognition, 1983) would argue that no single general ability can be abstracted from behaviour (in other words, there is no "universal grammar" of cognition). In this sense all cultures have to be considered equally effective in producing ways of dealing with problems of survival under unique constraints. On this view, it is not fair nor indeed possible to compare groups: we cannot use ethnocentric criteria to judge cultures as inferior or superior. We described the implications of cultural relativism in Chapter 1.4 above. Our current discussion of cross-cultural cognitive psychology is intended to present an approach that obviates relativistic difficulties.

Miller (1984) would hold that we should not in any event compare cultures in terms of manifest performances: rather, we should look at their different extrinsic and intrinsic generative mechanisms. He proposes a theory of the relation between culture and mind that we will describe below, one which he claims obviates the shortcomings of the relativist and the hereditarian views.

2.5.2 Mind and culture: a rational mode approach extended

Miller makes the distinction between being and becoming; both the above approaches treat mind (or intelligence) as a simple function of culture (or genes), and do not take into account the fact that this is a dynamic complex function, which indeed operates in several dimensions.

The relationship between the individual and the social has long been one of puzzle to psychologists and anthropologists alike; while some (e.g. Weber) have said that social objects are products of intentional human behaviour, others (e.g. Durkheim) have said that social objects are independent and coercive on the individual. A further development on these perspectives (given by Berger and Luckman 1967), is that there is a dialectal relationship between society and people, such that society produces the individuals who produce the society and so on. These three models as represented by Bhaskar (1979, p.40) are found in Figure 2.2.
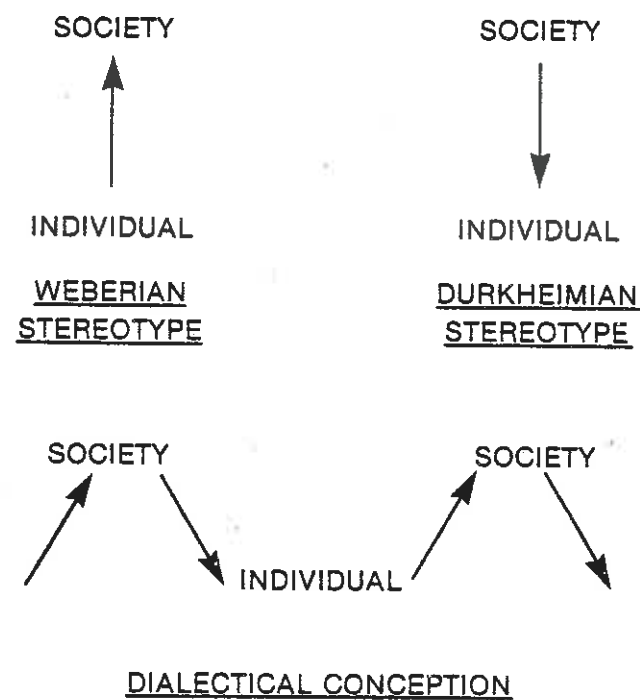
SOCIETY   SOCIETY

INDIVIDUAL   INDIVIDUAL

WEBERIAN   DURKHEIMIAN
STEREOTYPE   STEREOTYPE

SOCIETY   SOCIETY

INDIVIDUAL

DIALECTICAL CONCEPTION

Figure 2.2 Models depicting the society-individual connection (Miller, 1984)

In the dialectal model, society is regarded as an objectification or externalisation of man who is in turn understood as the internalisation of society. According to Bhaskar (op cit), people and society are not part of a dialectal unity - rather, they are radically different kinds of things. In place of the models represented above, Bhaskar proposes a transformational model (p.46), as depicted in Figure 2.3 below.
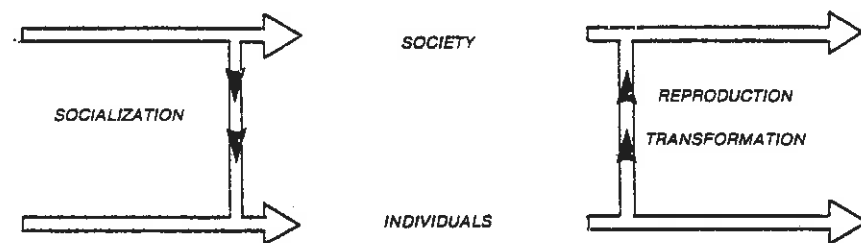
SOCIETY

SOCIALIZATION   REPRODUCTION

TRANSFORMATION

INDIVIDUALS

Figure 2.3 Bhaskar's (1979, p.46) transformational model of the society-person connection

Bhaskar (op cit, p.45-6) explains the intrinsic difference between individuals and society as follows:

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People do not create society. For it always pre-exists them and is a necessary condition for their activity. Rather society must be regarded as an ensemble of structures, practices and conventions which individuals reproduce or transform, but which would not exist unless they did so. Society does not exist independently of human activity (....). But it is not the product of it (....). Now the processes whereby the stocks of skills, competences and habits appropriate to a given social contexts, and necessary for the reproduction and /or transformation of society, are acquired and maintained could be generically referred to as 'socialisation'. It is important to stress that the reproduction and/or transformation of society, though for the most part unconsciously achieved, is nevertheless still an achievement, a skilled accomplishment of active subjects, not a mechanical consequent of antecedent conditions.

Miller (op cit) has pointed out that the linkage between the social and the individual is the proper object of study in trying to understand the relationship between mind and culture. He has elaborated Bhaskar's model, in an attempt to give a socio-psychological account of change - that very phenomenon that previous approaches have not been able to account for. He generates a second dimension from the primary datum of the social and individual domains. Firstly, in the social domain, he abstracts a set of roles, which he calls 'actors'. Now it is possible to conceptualize social forms, not as relations between individuals, but rather as relations between actors. Secondly, in the individual domain, the concept of a group is abstracted from the plurality of individuals. By doing this, Miller is able to clarify the distinction between group activity (group dynamics) and social forms (which are concerned with social actors).

So the primary domain is that suggested by Bhaskar: individuals and social form. The second domain is derived from this domain: actors in the social domain, and groups in the individual domain. The third dimension that Miller generates concerns the relations within and between domains. Very important is the fact that theories about social forms and individual agents cannot be related directly. Miller gives a clear example: the children that in all societies grow up to be competent are actors in the sense of abstracted role agents. However, when real children act out their roles as individuals being initiated into the specific forms of their society then we can be certain that some will be better actors than others.[3]

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[3] The explanatory power of this distinction that Miller makes is very great in terms of received psychological theory. For example, it enables us to get out of the impasse that Ogbu (1981) found himself in, when trying to decide between the notion that the origin of competence lies in early interaction and experience, and the alternative notion that the origins of human competence lie in the nature of culturally defined adult tasks. Now when a disadvantaged child wants to participate in western education, he could be judged to be incompetent, whereas in his own cultural terms, he is competent.

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It is in the context of action that these four analytic categories acquire a functional character. An individual in action is an individual actor, and similarly, social forms in action are manifest as social groups. The dialectic resides in the process whereby the individual engages in a role prescribed by a social form (mind-in-action), or alternatively a social form is expressed by a group comprised of individuals (culture-in-action).

The model that Miller himself draws to illustrate his extension of Bhaskar's model is three dimensional, and yet fails to do justice to the richness of the relationships between the categories and domains that he defines. Accordingly, I have redesigned his model, and this can be seen at Figure 2.4 overleaf, which does not show the three dimensionality, but the notion of action is represented: it is hoped that this model clearly explicates the important relationships within and between domains.

The notion of *action* is important for the understanding this model. If we take Porpora's (1983) conception that action is causally explainable in terms of the mental states of the actors (i.e. wants and beliefs), then his rational model theory conception provides for an integrated treatment of social structures and individual action. On this account, social structure is viewed as providing the conditions which influence the needs and interests of the actors. Depending on how their beliefs are affected by the social conditions, the actors respond with different desires. By acting purposively on their beliefs and desires the actors in turn produce both intended and unintended effects on the social structure, thereby modifying the conditions under which they subsequently act. Here is the significant way out of the impasse of the relativist notion of <u>static</u> culture. Hence, to refers back to Bhaskar's model above, the concept of change incorporates two complementary moments - both socialisation and transformation.

Socialisation is that aspect of change which is generated when cultural (or extrinsic) mechanisms are imposed on individuals and regulate their intrinsic mechanisms. The complementary aspect of change i.e. transformation operates when the individual (with his intrinsic generative mechanisms) exerts an influence on social performance.

Although socialization and transformation are necessary moments in a general theory of change, they are incomplete. They are both constrained by the state of the generative mechanisms that govern the *generative power of transaction* in the interpsychological space between individuals at any given moment in time. Biological, psychological and social systems are all seen to have generative power, and this generative power can change or be changed. The potential for change in these systems also governs the potential of actors to overcome specific constraints of reality.

3 One competence has reference on the individual level, and the other on the actor level.

- 36 -
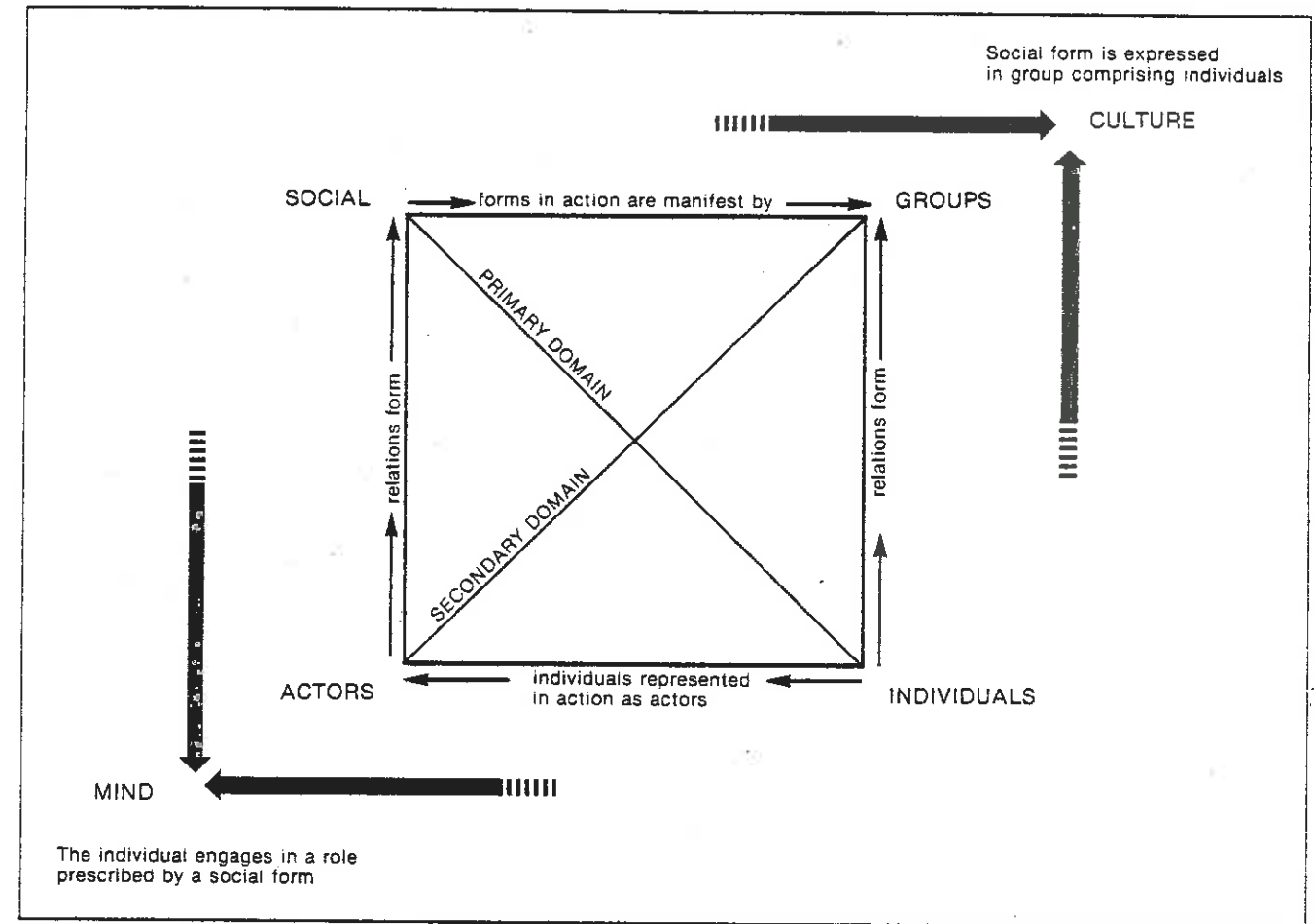
Figure 2.4 The relationship between the social and individual, culture and mind.

Further detail may be inferred from Miller's (ibid) model, if it has been interpreted correctly here, using Porpora's rational model theory. For example, there is that important aspect of *change* which has to be accounted for, and the third dimension of activity which Miller develops has reference here. He has referred to mind-in-action as the individual engaging in a role prescribed by social forms. The social forms themselves would be recreated or transformed by actors as an act of adaptation to their environment. The transformation could occur as a transaction between the individual (sic) actor and the environment (which incidentally is not represented in the model), which would lead to a change in mind, and feed back into social forms, or the transformation could take place in transaction between the actors themselves. However, if we refer back to our discussions on Piaget and the TCO, we will discern that the model would also need an account of when and how change would occur. We need a construct such as equilibration which would allow us, for example, to answer questions such as in what circumstances would individual actors or social forms change (mirroring a change in mind or culture).

The sophistication of this model would also allow us to further articulate and examine the two points which Miller <u>et al</u> raised in defence of

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universals of cognition. They argued that since culture is a product of human creativity, and that all human beings were able to cope with novelty, that the mechanisms of intelligent performance are in all likelihood invariant. Bhaskar argues that society is an ensemble of structures etc that pre-exist the individual, but that the individual (or actor, in Miller's terms) reproduces and transforms them. Can we strengthen our statement about universal aspects of cognition by maintaining that the principles of reproduction and transformation must themselves be universal, but that their manifestations could be variant? This would be a question about the nature of intrinsic mechanisms; and certainly, in turn, their manifest forms would show variability.

To test the constructs further: while we may accept that people (as individuals) are able to cope with novelty (and there will be variations amongst people as to the effectiveness of this capacity), we may be able question whether different social forms may be equally effective in adapting to novelty. We may for example want to be able to explain why, by and large, South East Asian social forms are more easily able to adapt to technological forms of thought than are African social forms. (We refer here to post World War II industrial revolutions in Japan, Taiwan, Korea etc.)

To be more general again: while we might accept in principle that there must be extrinsic generative mechanisms for change (in transactions between individuals), as well as intrinsic generative mechanisms (such as suggested by Piaget and Pascual-Leone), we need to further understand the nature of these mechanisms in order to better understand or facilitate change.

If we take together what we have learned from Pascual-Leone and Miller, then we will find that while their accounts are very powerful and sophisticated, in some respects they have a different focus or purpose from that in which we are interested, and therefore, from our perspective, some limitations. We should like to refer briefly to these.

1. The primary concern of Miller and Pascual-Leone has been to show the necessary universality of aspects of cognition. Although we have not gone into detail here about what is essentially a very deep argument, we would like to refer to problems with the approach once one starts to look at details. For example, while Pascual-Leone would have it that the form of subjective schemes must be universal, there might be difficulties with representing notions of truth and causation, in some kind of universal form, which he wants located here: or would these be transcendentally valid?

2. In looking at the relation between culture and mind, Miller sees the primary issue as not being how other people do our tricks (as Wober (1969) depicts the state of traditional cross-cultural studies), or how they do their tricks (the cultural relativist position), but it is to understand how we manage to do our tricks. Despite this apparent preoccupation with general issues of mind and culture, Miller and his colleagues have been concerned to look at how the process of change affects for example, Zulu people. From the perspective of

the Threshold Project, we are critically concerned to try to determine how we can better enable other people (specifically the children in black education) to do our tricks, i.e. formal school learning. Our focus, instead of being on establishing universals of cognition would be on trying to establish what extrinsic generative mechanisms are hindering the manifest performance of black children on school tasks.

3. Showing how people adapt to a western-urban-industrialised-schooled-technological (shall we call it WUIST) society is seen as an opportunity to watch how people participate in these socio-cultural forms, which may lead us to an understanding of how the generative mechanisms work that underlie our society. We would take issue with this, claiming that there may be a possibility that another society can change their overt (manifest) forms to approximate ours, but the generative mechanisms may be different.

4. If we accept that the silent operators of the TCO are universal, we are still free to acknowledge that executive schemes, a function of experience, are not. Education is primarily concerned with manifest performances, and these are at least a co-production of executive schemes and the silent operators. Self-regulatory processes, being culturally mediated, will affect both the content learned as well the executive schemes constructed. We will be examining approaches to self-regulatory processes in the next chapter.

In order to complete this section on cross-cultural cognitive psychology, we need to pay due attention to the cross-cultural research in the Piagetian paradigm.

2.5.3 Cross-cultural Piagetian research findings

According to Jahoda (1986) one of the main functions of cross-cultural psychology is to assess the range of applicability of theories originating in the first world. For example, researchers have tested Bowlby's (1969) attachment theory, and found that across-cultures children are not attached only to one caretaker. Piaget, at least implicitly, argued for the universality of his theory with the intrinsic generative mechanisms operating to develop logico-mathematical thought. At least in infancy, there seems to be impressive cultural similarities, so much so that Dasen (1984) would regard the stages of sensorimotor intelligence as "strong universals". However, after this period cognitive development displays cultural divergencies that have been variously interpreted. Piaget's theory spawned a great deal of cross-cultural research, reported in reviews such as those by Dasen (1972, 1977). Important convergences emerge that may be summarized as follows:

* The main stages postulated by Piaget have been generally confirmed as invariant;

* in many cultures there is a "lag" in particular domains;

* sometimes there is in traditional cultures an asymptote, seeming like arrested development in part of some populations.

Dasen himself does not accept any 'deficiency' interpretations of these findings.

Piaget himself (1966) was cautious about interpreting the results of cross-cultural research, since he saw scant evidence of what he regarded as prerequisites for competence in operational testing, namely, facility with the quasi-clinical method, ethnological sophistication, and a complete knowledge of the language. (These criteria would continue to be daunting to any cross-cultural research, and yet even independent of the details of Piagetian theory, they would seem to be apposite.) Taking up the issue of language Kamara and Easley (1977) point to methodological deficiencies in much of Piagetian cross-cultural replications. They point out that in order to use the clinical method effectively, interviewers must be competent in the child's language and his culture. If the interviewer cannot be alert for and probe into the distinction between the reality perceptions of the child and reliance on social cues, then the clinical interview - designed to get at the underlying concept - is reduced to a clinical test, in which the child's manifest performance is catalogued.

In practice, the principle focus of cross-cultural Piagetian research was on the verification of Piaget's stages. To start at the highest stage first. Formal operations are supposed to be achieved by adolescence, when the subject is supposed to attend to the form of the argument or statement, independent of the content of the statement. The system of transformations known as the INRC group is thought to form a model of adolescent thought, together with the combinatorial operations. In this Piaget has been criticized for failing to make logical sense (Parsons, 1960), although Pascual-Leone (pers. comm.), after close handling of the system with Inhelder (a collaborator of Piaget's) has stated that the logic is coherent. Piaget has also been criticized for failing to give an adequate account of formal operations (Lunzer, 1978) and for assuming that adolescent thought is best characterised as 'formal' (Neimark, 1975; Renner and Stafford, 1976; Kohlbert and Gilligan, 1971). Piaget (1972) considered at some length the problem of the absence of formal thinking in many adolescents' cognitive repertoire. His final view (p.208) was:

It is one thing to dissociate the form from the content in a field which is of interest to the subject and within which he can apply his curiosity and initiative, and another to be able to generalise this same spontaneity of research and comprehension to a field foreign to the subject's career and interest.

The capacity to think formally will also affect the understanding of traditional school subjects. Experimental work done in developed countries (e.g. Shayer, 1980; Collis, 1976; Brown, 1979) has shown that formal operations are not achieved by all pupils and yet formal thinking is a requirement of the curriculum, especially mathematics and science.

The mismatch between the syllabus and the child was taken so seriously in Britain that the Nuffield Ordinary-level chemistry syllabus was modified as a result (Turner, ibid).

Research in the South African context (M.A. Macdonald, 1980) has suggested that junior secondary science pupils in Ciskei largely do not move past the stage of concrete operations. Paralleling the Ciskei research, other studies of adolescent thought across cultures has shown that formal operations may not emerge at all (Dasen, 1977). However, in all cultures studied so far, what of the emergence of concrete operations? It seems (according to Dasen, 1972) that some or all of the individuals reach the stage of concrete operations, although usually at a later age than middle-class Westerners.

Dasen (ibid) refers in a preliminary way to the positive effects of producing Piagetian-like thinking modes in situations of contact with Western modes of thinking, partly through schooling, and partly through urbanisation. This issue has been reviewed in detail by Akinnaso (1981), Erickson (1984) and Stevenson (1982).

In summary, what is of interest here are the general reasons why there are these developmental differences across cultures. Dasen (1982) has distinguished between competence (universal aspects) and performance (showing constraints of real-life factors). Giving specific training helps to distinguish the two. Jahoda summarises Dasen's argument as follows (p. 423):

If a concept has pragmatic value within a cultural context, there will be no asymptote and any lags can be eliminated by short-term training. Such cultural differences are thus confined to the realm of 'performance' and this would include cases where the original assessment was vitiated by inadequate measurement ..... When training fails, no certain conclusion may be drawn since it does not follow that 'competence' is necessarily absent; shortcomings in the training procedure may have been responsible ....

Piaget himself (1966, 1974) acknowledged that there are four main factors interacting to enable the child to acquire progressively more complex structures of thought:

a) maturation, which he sees as purely biological interactions between the geneotypes and the physical environment;

b) equilibration, on which he places the heaviest burden of explanation. It is seen as relatively independent of biological factors and the social environment, and therefore as requiring cross-cultural verification;

c) general socialisation which is seen as independent of education transmission. It is seen as general (asking questions, exchanging information), as well as specifically crystallized in different ways in each society; and

d) educational and cultural transmissions which are considered as culturally divergent. The cognitive processes are seen to be able to vary, and Piaget would have to start with an analysis of languages, which are not likely to have an effect on cognitive operations themselves, but on the detail of conceptualizations, for example, relations, and the content of classifications.

Piaget had hoped that cross-cultural research would untangle the effect of biological, physical and social factors. However, Jahoda (ibid) feels that after extensive cross-cultural research we are no clearer in shedding light on the "nebulous frontier" between environment and maturation.

On the central factor-equilibration, Jahoda is even more sceptical. He feels that equilibration may parallel "cognitive dissonance" in postulating a need to avoid inconsistency, and two problems arise here. Firstly, apart from social pressure, such a need may not arise; secondly (and more damningly) Jahoda suggests that there is no objective criterion for establishing the existence of inconsistency. Inconsistency, he feels will depend on social representation. He would prefer to view contradictions as arising in experience specially tailored to the child's current level of understanding (which is more in accord with the Vygotskian paradigm discussed below at 2.6).

The earliest construal of Piagetian theory was what Berry, Dasen and Sartorius (1988) have called the absolutist orientation; in other words, the universality of the theory was postulated without seeking empirical proof. Dasen and de Ribaupierre (1987) report that such an absolutist Piagetian approach has been criticised repeatedly because its interpretation of comparative data might lead to ethnocentric, middle class value judgements. Dasen and de Ribaupierre (ibid) align themselves with what Berry et al (op cit) call the universalist orientation; in Piagetian terms this would translate to the universal characteristics of operational thought having been established empirically, and the cultural variations being linked to the eco-cultural context. The empirical research shows species wide continuity of basic cognitive processes, but cultural variation in the way these are developed and deployed. Specifically, following a review of neo-Piagetian cross-cultural research they suggest that some basic features of cognition, particularly basic information-processing capacity (M-capacity) and some aspects of system mappings (eg transitive inferences) may be universal.

The link between the eco-cultural variables and the developmental outcomes occurs through the learning context i.e. the enculturation and socialization practices during infancy and childhood. A useful summary and model of research in this area has been provided by Super and Harkness (1986) in terms of the notion of "developmental niche" that has three components:

1. The physical and social settings in which the child lives;

2. the customs of child-care and child rearing, and

3. the psychology of the caretakers, or parental ethnotheories of development.

When Piagetian theorists find the need for an account of the 'developmental niche' then they have moved into a position where they can (and perhaps, must) co-ordinate their research with that which has been carried out within the Vygotskian paradigm. The paradigm is described at 2.7 below, and possible co-ordinations at 2.8.

2.6 COGNITIVE DEVELOPMENTAL RESEARCH ON THE THRESHOLD PROJECT: THE NEO-PIAGETIAN MODEL OF LE BONNIEC

2.6.1 The Box Task and Epistemic Modality

The notions of possibility and necessity are of considerable interest in relation to children's thinking as well as their language. According to Donaldson (1976, p.278) "consideration of possibilities is at the root of inferential thinking". She has also observed that the quite young child has some intuition of possible states of affairs in the sense that he is aware, at least fleetingly, of uncertainty about particular external happenings and tries to resolve this uncertainty, as swiftly as possible. A much later notion is that of "the possible", the attitude that entertains a possibility, represented and attended to as a mental event.

For Piaget (see particularly Inhelder and Piaget 1964) the comprehension of possibility and necessity is the result of a long evolution, culminating in the achievements of the formal operational period. The preoperational child (2-7 years) is more likely to explain situations in terms of the characteristics of their configurations at a given moment than in terms of the changes leading from one situation to another.

Compared to preoperational or intuitive thought, concrete operational thought (7-11 years) is characterised by the simple extension of the actual, or reality, in the direction of the potential, or possible. For example, to classify a set of objects means that one constructs a set of class inclusions such that at a later point new objects can be included in a systematic relationship with those already classified. New class inclusions are thus always possible, but Piaget is anxious that we do not equate these "possibilities" with a set of hypotheses; any hypotheses that the child does formulate are no more than outline plans for possible actions.

The most distinctive feature of formal operational thought (from 11 years upwards and only in specific situations) is that it is hypothetico-deductive : this type of thinking proceeds from what is pos-

sible to what is empirically real. The deduction refers to the hypothetical statements rather than real perceptions. Instead of deriving a theory from empirical data as well as concrete inferences, formal thought begins with the postulation that certain relations are "necessary": deductions derived from true hypotheses are necessarily true.

Piaget would hold that the operations of thought could be adequately decribed by propositional logic (or indeed that the child constructs such a logic). However two valued logic has been seen to be inadequate to describe natural thought insofar as for example, the operator (if ... then) is a source of paradox, since it permits inferring the truth of an argument from the falseness of an antecedent. (In fact p⊃q is false if and only if p is true and q is false.)

Since implication is of special interest – because we could take (hypothetico-deductive) thought to be concerned with arriving at a deduction based on a true or hypothetical premiss – we need an alternative account of it for a psychological theory. Le Bonniec (1980) purports to give such an account in a three-stage structuralist neo-Piagetian model. In the third stage of alethic modality, the schema

<div align="center">Nonpossiblity of X ===> Necessity of non-X.</div>

is attributed to the child, who is seen to be operating within the Aristotelian logical square of modalities.

In this section we shall be focussing on the second stage of this theory in which Le Bonniec is concerned to demonstrate the child's capacity to consider eventualities, or possible events. Apart from having integrity within an epigenetic (stage-based) system, the second stage of epistemic modality is of broader interest insofar as it transparently describes the reflexivity of thought in metacognition. To date there does not appear to have been much interest in the phenomenon of metacognition cross-culturally. The Threshold research may open up this field.
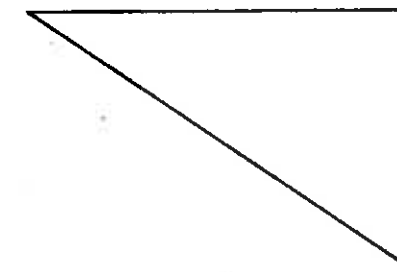
On Le Bonniec's account, the child becomes able to imagine nonpresent objects or the properties of such objects, conscious of the fact that certain information may be lacking in the imaging. He may also imagine an event with sufficient detachment also to imagine modifications during the event. The child comes to speak in terms of events detached from any specific instantiation. This capacity to doubt, to recognise that one doesn't know is initially applicable only in concrete situations. The criterion for the attainment of epistemic modality is that the child is able to maintain uncertainty throughout the reasoning process. This allows the child to differentiate between instances where information is lacking for making a decision, to cases where the information is complete and allows for a determinate decision. The child's capacity to remain in uncertainty develops by about ten years.

Le Bonniec describes the child's epistemic capacity in terms of a three-valued system, seen in Figure 2.5.

From developmental psycholinguistic work in English (e.g. Macdonald, 1983) we know that the child expresses epistemic modality using auxil-

iary and non-auxiliary forms from as early as 4 years. However Le Bonniec operates in a typically Piagetian fashion by specifying stringent criteria which the child must meet in order to be able to attribute a cognitive structure to him. Evidence which she adduces for the attainment of this structure comes from her experiment called simply "The Box". In this section we report replications of Le Bonniec's (1980) experiment, with five different groups of children.

The "Box" we used was specially constructed, with a square and a slit opening, and a marble and a small thin stick. The square could accommodate both objects, but the slit only the stick. The marble could only go through the square opening, but the stick could go through both. The children were introduced to the compartmentalised box and the objects, and practised answering questions about them after a screen was put up.

Then the questions were asked again twice, as part of the test phase. There were two types. The indeterminate questions relate to which hole the stick is going to go through, and what object is going to go through the square hole. Determinate questions relate to the small hole (only a stick goes through) and the marble (it only goes through the square hole). A competent indeterminate answer would be "We have to open the door, because we don't know whether the stick has gone through the small hole or the big one".

On the basis of Le Bonniec's results, we expect distinct patterns of responses to emerge ranging from competence, to sterotypic or magical answers, to total incompetence on the task.

1. Complete success in all the items with correct justifications and resistance to the counter examples given by the experimenter (e.g. "one child told me just now that ...").

2. Success on all the determinate items with correct justifications. In the indeterminate situations the subjects give varying responses. Sometimes they say that they cannot find the answer, and sometimes they import premisses external to the situation. In general they cannot accept that there is no "logical" solution to the indeterminate as opposed to the determinate situations, and that it is necessary to verify this by opening the door.

3. In this group there is also success on the determinate items. In the indeterminate situations, the subject declared there is no need to open the door. Solutions may be stereotyped; justifications are never external to the system i.e. they are not logically formulated but rather refer to the properties of the box. Our pattern differs slightly from Le Bonniec's, in which indeterminacy relating to both objects entering the wide hole is supposed to be more difficult than indeterminacy relating to the stick. In our studies both kinds of indeterminacy seemed to be equally difficult. The differences in performance may relate to the introductory stage, where unlike Le Bonniec, we asked "symmetrical" questions about the objects and apertures.

4. Responses in this group indicate general confusion and perhaps total incomprehension of the system. Here it is difficult for the experimenter's to discern the decision rule for the child's behaviour.

Le Bonniec goes into a great deal of detail in her report, and also covered children of every age between 4 and 10 years. For our purposes it is appropriate to report on the children of the same age as our subjects. Let us see then how the French children fared: at the age of 6 their most typical responses were those of patterns 2 and 3. That is, most of them (93%) have the notion of determinacy, (the total of patterns 1,2 and 3) while a large proportion of them showed the beginnings of an understanding of indeterminacy (42%). By the age of 8, pattern two is still the most common, but now a third of the children have control on both determinacy and indeterminacy. The most mature pattern predominates by the time the children are 10 (83%).

We compared the results of the original French sample with multicultural, Bapedi, Batswana and Scottish groups. The Scottish children showed the same response pattern as the French children (except perhaps slighty advanced), which indicates that a distinct developmental effect has been uncovered. The multicultural group (church school) group showed the same trend, but there was a slight developmental lag relative to the first two groups. However, the Bapedi group failed to produce any child capable of understanding determinacy and indeterminacy completely. Furthermore, there was not a clear developmental pattern across Grade 1, Standard 1 and Standard 3, and a high proportion of the oldest children showed pattern four, i.e. confusion. However, the Batswana group (which came from the best school in the Primary Education Upgrading Project) showed a coherent developmental picture, lagging slightly behind the multicultural group. (These results are summarised in Figure 2.6).

There were also striking differences with regard to the children's justifications. Irrelevant justifications which occur in patterns 2 and 3 dropped away completely by Standard 3 with the Scottish and multicultural groups, but perservered with the Batswana and Bapedi children. A similar but even more striking pattern occurred with the canonical justifications ("the stick belongs with the slot"), which were much more common amongst the Bapedi and Batswana children. The children were sticking to the concrete "connections" between object and aperture. This is an added dimension to the results which is perhaps a reflection of the fact that black children are very seldom asked to give a justi-

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fication for what they, personally, think. Although we cannot be certain of the learning histories of these children, the notion of choice in a game-like situation with an adult would seem to be remote to them.

KEY: ———— French
···················· English
— — — Multicultural
—·—·—·— Bapedi
—···—···—···· Batswana
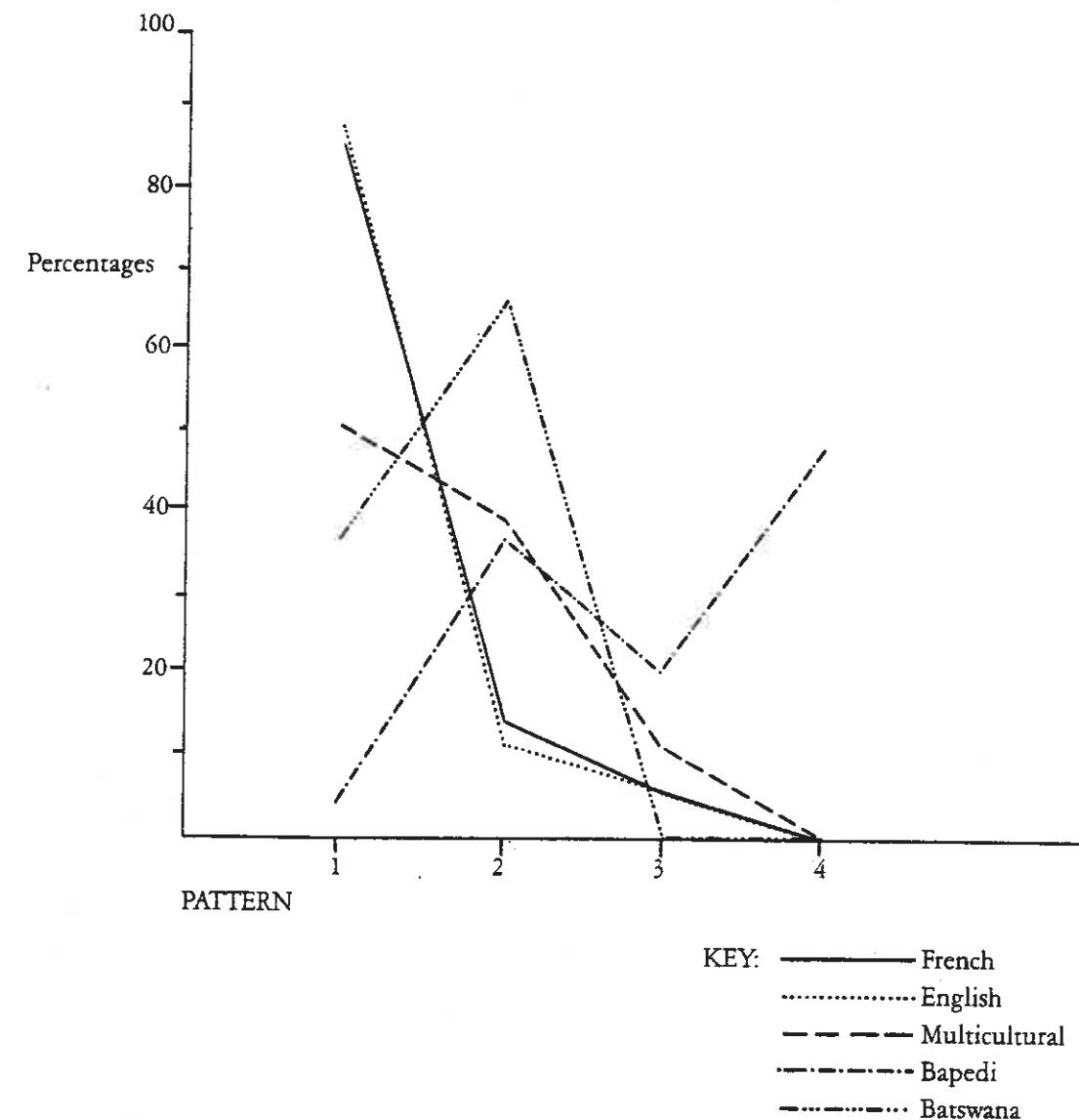
Figure 2.6 Patterns at fifth grade on the Box Task

Something else which was noted was that the Scottish children were very much more likely to give a "logical" rather than a descriptive justification for the determinate questions. Asked about the narrow hole, they were much more likely to say "The marble can't go through the narrow hole", [4] than to say "Only the stick can go through the narrow hole".

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[4] There is striking parallel in this task and the picture ordering task reported earlier at 2.3.4. The justifications are both in

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In other words, they were balancing up the system that they were working in, and systematically using all four elements, setting up a co-ordination between object and aperture.

What we do not yet know is whether children who give "logical" justi-fications are also more likely to be able to generate hypotheses in a more open and creative problem-solving environment, such as might be found in the science classroom. We need to determine whether there is such an association, if we are to determine the relevance of alethic and epistemic modality to hypothetico-deductive learning in the primary classroom. What we venture to hypothesise is that these modal reasoning capacities will be of relevance educationally, and for no less reason than exploring the nature of the justification that the child gives. We have carried out another study, reported below, on alethic modality in a cross-cultural research design. The need for further research is clearly indicated on problems where there is a closed system of choices, and children can work out what is possible or necessary within it.

2.6.2 The Circles Task and Alethic Modality

As we have seen in the section above, for Piaget the notion of possiblity undergoes a transformation during the course of development. The concrete operational child is able to conceive of the possible as a simple extension of the actual. The formal operational concept of pos-sibility treats the hypothetical as primary : thinking proceeds from what is possible to what is empirically real. Deductions derived from true hypotheses are necessarily true.

In the Kantian system the notion of necessity is conceived as a pre-established frame of reference. Since Piaget is not a nativist he has to explain in his own terms the development of the notion of logical neces-sity. For him, the notion is progressively constructed : with the devel-opment of reflexive thought (loosely, metacognition) there is a progressive decentralisation of the child in perceiving the operations of his own mind. This enables a change from egocentric consciousness to "knowledge", and the child comes to construct self-evident (i.e. self-constructed) norms. The notion of necessity would then correspond to "the progressive internal coherence of open-ended constructions" (Piaget 1967, p.391).

Here we have a very strong hypothesis that the operational structures which correspond to a certain level of thought also correspond to cer-tain "level" of necessity. This view has not been salient in Piaget's

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4 terms of "what can't be", therefore the reverse is necessarily the case. Both these patterns of justiciation in fact formally qualify as 'alethic' in Le Bonniec's terms.

writing (see however his work with Inhelder (1964)), but is the corner-stone of Le Bonniec's revision.

It would appear that Le Bonniec's theory has a stronger case for psycho-logical reality, than does Piaget's, insofar as her model predicts greater continuity in the development of cognition. We are referring to the unsatisfactory "reversal of directions" between reality and possi-bility at the onset of formal operations, justified by the notion of po-tential operations (in other words, possibility is logically prior.) Le Bonniec sees this analysis as simply being an attribution of logical calculus to the subject, without regard for his thinking behaviour.

If we take hypothetico-deductive thought to be most typically concerned with arriving at a deduction based on a true or hypothetical premiss, then we must give an adequate account of the process of *implication*.

Le Bonniec purports to do this in her three stage theory.

The pinacle of cognitive development is described in the child's operat-ing within the Aristotelian logical square of modalities. Modality may be introduced at either the level of predicate logic or that of proposi-tional logic and Aristotelian logic is situated at the predicate level. The Piagetian logic is propositional, whereas Le Bonniec's is predicative and thus potentially able to integrate the semantics of the proposition, so it appears to furnish a closer approximation of natural thought than does Piaget's system.

Le Bonniec replaces the relationship of implication in classical logic with the schema:

Nonpossibility of X ====> Necessity of non-X

However, once again Le Bonniec is concerned with modelling the behaviour of the child. For her, it is important that the model give an account for example, of the fact that at the stage of concrete operations child-ren only retain the positive results of an experiment, whereas at formal operations they retain both the positive and negative results. Infer-ences from both types of results are necessary to "discover" the idea of necessary reciprocity, described in the schema above. In her logic, re-jections acquire a positive character in themselves.

In summary then, Le Bonniec contends that predicate logic is more appro-priate than propositional logic as a means of understanding the acquisi-tion of the notion of logical necessity. The "feeling" of logical necessity could arise from the simultaneous consideration of observable cases of possibilty and impossibility. The logic of the Aristotelian square constitutes a closed system, which she holds gives the child the feeling of necessity inherent in the perception of the closure.

For Le Bonniec, as with Piaget, a coherent structure necessarily has an origin, and the origins are found at the prelogical level. The first stage that she posits is the pragmatic stage of modal reasoning (which we did not address in our research). The relationship between the sec-ond, epistemic stage, and the third, the alethic, both of which are our

concern, is very closely linked. The basis for alethic modality lies firmly in epistemic modality. Le Bonniec describes this succintly (ibid, p.61)

... a good criterion would seem to be the ability to distin-guish between problems involving a necessary solution and those, where, because of insufficient information, the solution is inde-terminate. The perception of indeterminate situations is impor-tant for two reasons. First, it is only in relation to indeterminate situations that the child recognises those in which the deductions have the character of necessity. Logical necessity is meaningful only in relation to logical nonnecessity. Secondly, the perception of nonnecessity permits hypothetical thought. *To hypothesise it is first necessary to reason on the basis of inde-termination* (our emphasis). By definition, an hypothesis presup-poses the possibility of framing alternative hypotheses. Any given hypothesis is therefore logically nonnecessary, even if all the possible hypotheses are determined by the situation; any addi-tional information can only entail the attribution of true or false values.

The Box Task only provided us with information about the way in which the distinction is made between the *decidable* and the *undecidable*. In a situation where no hypotheses have to be made. Furthermore we only asked the child to remain in "undecidability" insofar as they had to give consistent judgements of "We can't tell" over repeated questions in order to be classified as using the most mature pattern. However, in the present study, it was crucial that the child maintain uncertainty, in order that they could consider cases where the information is lacking to that where it is complete. Remaining in uncertainty is the necessary but not sufficient condition for achieving the system of alethic modality; it is the reflection of the feeling that a decision criterion is lacking (which is the correlate of nonnecessity).

The criterion for the alethic stage is the justification of undecidability by the stating of two hypotheses, of the general form "If the value of X is A, the result will be ..., if it is ~A, the result will be ...."

The statement of the two hypotheses Le Bonniec calls *the conditional op-eration,* which she claims appears only at the level of a total de-scription of the system and as a condition of choice between the decidable and the undecidable. In the Box experiment the situation is decidable if the experimenter uses the marble or the narrow hole, and undecidable if the experimenter uses the stick or the wide hole. No hy-potheses are required, since the subject is told which situation he is in.

In the present study we take the study of modal reasoning a step fur-ther. Here the child has to use hypothetical information in order to de-termine the truth of a proposition. This alethic reasoning is a critical development since now the grounds for establishing the truth or falsity of a proposition are constituted.

In the present study the child comes to use hypothethical information in order to determine the truth of a proposition. The materials here are in the first instance, a half circle (say RED) and a half-circle covered with foil (say RED or BLUE). The child has to reason from what he can see - the red half circle, and what he knows is possible - a red or blue half circle. For example, if the child is asked "will the circle be of one or two colours", he would be expected to respond: "one cannot know; if the wrapped circle is red, it will be of one circle; if the wrapped circle is blue, it will be of two colours."

In the second phase of the experiment the child has three half-circles in front of her, i.e. RED - FOILED - BLUE. Similar questions to the first phase are asked e.g. "Can there be a circle of one colour" to which the answer would be "Yes there can be, because if this wrapped half-circle is blue, the circle will be blue, and if its red, the circle will be red."

The results of this experiment are extremely complex, since our simpli-fications of the original French questions left comparatively simpler and therefore perhaps different experiment from that of Le Bonniec. There were objective epistemic questions (where one doesn't know, but can state the condition for something being the case), alethic possibil-ity (decidable on the basis of an hypothesis) questions, and alethic ne-cessity (decidable on the basis of an unknown) questions. The multicultural church school group of children (Grade 1, Standard 1 and Standard 3) did better than their French cohorts, and consequently it seemed as though they acquired alethic modality before epistemic modality, contrary to Le Bonniec's developmental hypothesis. Looking at the French questions, we felt that the children's performance was proba-bly artificially depressed by the difficulty of the language in which the questions were couched. Hence the epistemic-alethic development was not empirically proven, although the Circles task was more difficult than the Box one.

However the Bapedi children that we worked with showed a peculiar pat-tern of responses on this task. For example, given RED + FOIL and asked "if the circle is of one colour only, what colour will it be?" they would answer "Red, because the other half is red or blue". Logically speaking "the other half would have to be red". It is possible that the children gave this response, because the experimenter went to great pains to show the child the different combinations of circles (BLUE, RED, and BLUE-and-RED), and then check that they knew that the foiled element was either red or blue. This kind of justification would seem to indicate that the children may have had insight into the question, but were thrown by the original explanation, and/or couldn't justify their thinking.

On other questions, children refused to hypothesise about the possible values of the foiled element. They said that they couldn't answer be-cause they did not know what was under the foil. This was tantamount to refusing the task, and is a more serious indication of a lack of con-ception of what such a task would normally entail.

It may be that the children did not see fit to hypothesise about a situation that made little sense to them. However, if we were to design a task structurally similar but closer to the child's experience, black children might be willing to make hypotheses of the sort Le Bonniec searches for: however we might simply bump our heads on a cultural "rule" which says "Why bother to hypothesize about something when the information is being deliberately withheld from you?"

2.6.3 Critique of Le Bonniec's theory and its implications for the Threshold Project problem domain

The concepts of possibility and necessity are important for the development of inferential thinking. However, it is possible to conceive of the concepts in different ways and at different levels. Le Bonniec has done a penetrating critique of the shortcomings of Piaget's concept of possibility at the stage of formal operations.

As a classic neo-Piagetian theory, Le Bonniec's theory is open to the same criticisms as Piaget's, i.e.

1. It is a structural theory, rather than a process-structural theory, and to that extent lacks power at the level of psychological reality.

2. Le Bonniec has no construct by which to explain change. For example, she talks about the necessary but not sufficient condition for achieving alethic modality, but there is no mechanism which would account for the actual conditions and operations of change.

There are other difficulties too. In the formulations of her questions, Le Bonniec, unlike Piaget, does not attempt to introduce cognitive conflicts between perceptual and operative thinking by deliberately asking ambiguous questions. However, the sheer complexity of the language of her questions may have led her to underestimate her subjects problem-solving capacity. By revising her language, but attempting to keep the concepts the same, we may have inadvertently undermined the epigenetic nature of her stage model (that is, we showed that it was not necessary to have achieved epistemic modality before constructing alethic modality). However, we cannot exclude the possibility that her structural account is sound, but that her tasks do not truly represent these structures.

From a pedagogic point of view (bearing in mind general research on metacognition), we feel there is real productivity in the structure of three-valued epistemic cognition. From the point of view of authentic problem-solving, it is critical that the child should be able to identify instances where he has insufficient information for making a decision. Too much of conventional instruction encourages the child to make premature closure i.e. making decisions on insufficient or irrelevant

evidence. By this we refer to the 'factual' nature of typical classroom discourse.

In terms of what we have discussed in this chapter, we can tentatively offer a developmental sequence towards the development of this "epistemic" capacity:

1. The child has fleeting intuitions of possible events.

2. He knows or is aware of alternative situations that can be concretely visualised or conceptualised.

3. The child knows that he knows (metacognition) of alternative situations.

4. The child has cognitions that there are situations that one is not certain of.

5. He has metacognition that there are situations that one doesn't know about.

This epistemic cognition should not be confused with the concept with the same name as used by Strohm-Kitchener (1983) although we believe the two could be linked developmentally.

We assume that there is an ontological (developmental) hiatus between this structure, and the alethic structure, in which the child has to use hypothetical information in order to determine the truth of a proposition, and furthermore, in a double conditional. (If X, then Y or if ~X, then ~Y.) The only point of entry for the epistemic structure is in the first stage of reasoning here i.e.

1. *I don't know whether X or not X.*

After this, the very act of inferencing (which has other roots), joins the action in something like the following:

2. There's a possibility that X or ~X

3. If X, then all Y; if ~X, then not all Y.

(Translated into the terms of the task: "If this half circle is red, then the circle will be all red; if this half circle is not red, then the circle is not all red.")

4. Then the co-ordination: if X, then all Y, or if ~X, then not all Y.

The reasons for the "failure" of the indigenous subject groups on the two groups are probably manifold. We suggest that the factors could fall into two main groups i.e. firstly, task unfamiliarity/disembeddedness, and secondly, the contradiction between the underlying task demands and 'indigenous mediational operators', (cf 2.8.2 and 2.8.3 below).

Firstly, the tasks that Piagetians dream up are always unexpected - they are supposed to put children into surprising situations, to think about things they have not encountered before. However, the notion of being presented with an unfamiliar task may not be unexpected in itself for western children, who might take on such a situation as a challenge. However it may be unfair in the indigenous culture to give children unfamiliar tasks for their own sakes; the purpose of a new task is that children should learn how to do it (at least in its manifest form). Secondly, the Western children may well be more used to tasks which have no bearing on everyday problem-solving, that is, problems that are esoteric ends in themselves.

Thirdly, (anticipating sections 2.8.2 and 2.8.3 below) the way in which these tasks were carried out would have violated the co-operative problem-solving mode that Kok (1986) identified. For example, the tester tried to help the child understand the underlying task demands (especially in the Box Task), and asked the child whether he could reproduce an understanding of these same underlying demands, without giving the child any superficial level clues for "guidance". This is the deepest level of explanation that we can give with our current insight into indigenous mediational operators.

However, in the Box Task, we did find a schooling effect, which would seem to be overcoming the culture effect. This means that the quality of the schooling may well be affecting the way children are beginning to think. When one bears in mind that the children came from the school which is the best exponent of the PEUP child-centred method, then one can surmise that aspects of this method are causally implicated in the change of thinking patterns. As we have explained in our School-Based Learning Experiences final report, such children would not typically be faced with problem-solving tasks. However they are learning to be more autonomous managers of their own tasks when they are assigned group work. But the connection between these "coarse" self-management changes and changes in strategies in approaching tasks is not yet clear to us. Furthermore even these children had problems with the circles task, and here we can only conclude that perhaps, at this level, the children were almost totally lacking in any exposure to forms of deductive thinking. Although our in-school observations would tend towards this conclusion, probably further evidence is necessary to make a stronger statement.

Our original supposition was that Le Bonniec's theory might be a better candidate for an adequate psychological model of thought in our situation, but we failed to take account of the ways (like Piaget's theory) that it fails (we have Pascual-Leone, pers. comm., to thank for this insight). However, we did find that Le Bonniec's stages are perhaps not invariant in their acquisition, possibly because of an artefactual condition of unduly complex language in which the questions were couched.

We have already pointed out the relative merits of addressing the epistemic structure in education. Although we have less to say about hypothetico-deductive thinking, it would seem that there is a deep divide between WUIST-type (Western-urban-industrialized-schooled-technological) children and black children in their typical school situations. It seems that we should institute more research on models

of instilling this kind of thinking, but it would have to be negotiated in an action research model with the teachers.

Bearing in mind that we had asked the children to do our very unusual model logic tricks, we thought it might be more productive to ask children to do cognitive tasks involving aspects of metacognition, i.e. especially strategies and justifications, that were more typical of the school situation. These tasks we have already reported on, in the section about metacognition (2.3.3) above.

2.7 COGNITIVE DEVELOPMENT: THE VYGOTSKIAN PARADIGM

2.7.1 Basic concepts of the paradigm[5]

Piaget (1977) developed the notion of equilibration as the explanatory construct for the development of knowledge. The concept of 'non-balance' is central to his model indicating a conflict between what the subject can do and does know during the interaction with an object of knowledge, and what the object demands in terms of potential accommodation. In general terms it is important to determine how a non-balance may arise in a system of knowledge, and what may serve as an (educational) resource for surmounting the conflict.

Vygotsky's (1978) analysis of cognitive constraints, which places these in the context of actual social relations, takes us further than Piaget's analysis does. He focusses on an analysis of how the non-balance arises, and locates it in the mediator, or cultural guide. So, Vygotsky's analysis can potentially address the social actor (centrally), the social processes underlying cognitive development (also crucial), his material conditions of existence, and the social communication between people.

In this paradigm the origin of *self-regulatory activities,* which include [self-regulatory activities] higher order thinking skills, lies in culturally prescribed patterns of control. These patterns are exercised at first by a mediator, and later the child internalises these controls. At the societal level, the same happens when an adapting system (e.g. black education) enters an unfamiliar reality, that is, one that is the product of another socio-political development trajectory (e.g. western, white education). The

5 This section is similar to section 1.3 of the sister report School Based Learning Experiences (SBLE). Most of theoretical points made here (although not all the examples) are directly derived from Anita Craig's exegesis of development and change, published in various documents (1985, 1986, 1987, 1988.) If there are any misinterpretations in this integration, this author takes full responsibility.

adapting system (black education) may internalise through social transaction the regulation exercised by the mediation agents of the adapted system (perhaps the private school system). In this context, the modes of regulation may change one or both of the systems.[6]

Because fundamental social transaction is limited or even prohibited in our society, this means that occasions for adaptation are absent or heavily restricted. So the two systems are left largely opaque to the other. Crucially, what is left opaque, are the hidden meanings of the taken-for-granted practices, beliefs, and so forth, of each system. What, for example, counts as learning worthy of reward?

As Vygotsky points out, outward appearances conceal the internal nature or processes that silently underpin social activity. In formal western schooling, much of what goes on might simply be 'the way things are done' (although the way things are done lead to, other, unanticipated cognitive benefits). For the non-Western mother and teacher, the child's entry into social forms underlying Western schooling is complicated by the fact that meanings are obscured and reasons unintelligible. Culturally more consonant forms may replace the opaque forms. In other words, the black child may do the same thing as a white child for completely different reasons and perhaps, with rather different consequences.

Social actors are mostly unaware of the 'hidden curriculum' of everyday tasks. The ability to move freely, to communicate needs, to be self-sufficient, to uphold authority relations, to preserve and use social knowledge, etc, carry with them a host of opportunities for learning the skills required in that society. With change, traditional tasks (such as animal husbandry, weaving, etc.) may be displaced. The real loss here is not the tasks themselves, but rather the *opportunities for learning* which these tasks embody. New goals may ensure that conventional patterns of behaviour become devalued, inappropriate or even impossible. The culture has to make a paradigm shift; and in the grey land between paradigms there may be a loss of cognitive efficacy. In other words the social forms do not necessarily achieve new social goals. We would assume that while making the paradigm shift the social actors might necessarily experience the feeling of being disempowered. This loss of positive affect would have an effect on subsequent learning experiences.

Mothers' or teachers' expressed beliefs about appropriate behaviour (for example, not looking the adult in the eye) may not be actualised with the same frequency as the adults believe. Nevertheless, Craig believes that these beliefs are an important data base from which to construct an

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6 The private schools, with one notable exception (the NEST schools) are still clinging to an English-speaking identity, but this much protected social form will, in time, adapt to the social forms brought to it by actors from a different reality. It is a great pity, if not an injustice, that genuine transactions towards radically new social forms are not being actively sought. cf. the Consolidated Main Report for further discussion on this issue.

analysis of the conditions for change. For example, it may be the case that authoritarian-submissive beliefs and practices are actually antagonistic to, for example, teaching children to seek independently for information.

Research on Zulu mothers (Craig, 1985) showed that they viewed *teaching* in context embedded terms, such as example and demonstration, and *learning* in similarly embedded terms such as as observation and imitation (we will see more of this in 2.8.3 below). However, formal western schooling reduces contextual learning, and if this kind of learning is not going to be mediated in the home, then the primary agency of mediation for this will be the school itself. The school will have to be the mediating agency between the known and the new realities. Herein lies the deepest challenge, because for example, teachers respond to the expressed values of parents (partly because they are themselves parents) and are therefore not autonomous agencies. Also, they themselves may not be aware of the forms they are participating in, nor of the consequences of the same.

Mediation is a technical concept of Vygotskian theory - the mechanism of individual development is rooted in society and culture (1978,p.30):

From the very first day of the child's development his activities acquire a meaning of their own in a system of social behaviour, and being directed towards a definite purpose, are refracted through the prism of the child's development. The path from object to child and from child to object passes through another person. This complex human structure is the product of a development process deeply rooted in the links between individual and social history.

So the *mediator* has a critical role in determining the course of development. While on the one hand the child brings to the situation his potential, and the power of equilibration (an intrinsic generative mechanism) to resolve unfamiliarity, interpsychological functioning with the mediator allows for learning through transaction (an extrinsic generative mechanism). The mediator or teacher will naturally use what she knows about the world and the task at hand. It is here that we find the impetus behind socialising children into familiar social forms or tasks. But in the 'newer' reality of formal schooling, tasks will bring their own demands.

These task demands may function as mediators themselves insofar as they present the teacher and the child with the occasion for resolving the 'non-balances' which may occur. However, in the absence of resources to surmount the conflict (or even to recognise one), adaptation, or genuine learning, will not occur. So, it is not sufficient to present children with task demands which create non-balance; the teacher must have the resources to resolve these. Well-meaning educationists then should not independently produce completely novel packages of "teacher proof materials", since such materials do not create an interface between realities, but may only serve to nullify those abilities, skills, experience and knowledge that the teachers already have.

An interesting and far-reaching distinction is made between development and learning. For Vygotsky, the child's ==developmental level is assessed in terms of her ability to solve problems unassisted.== In contrast, the child's ==learning exceeds this developmental level and can be determined by assessing which additional problems the child can solve in collaboration with an adult or a peer.== This is Vygotsky's conception of the ==Zone of Proximal Development== (ibid, p.86), which has been articulately extended in the work of Craig (1985) and Kok (1986):

ZPD

> It is the distance between the actual development levels as determined by individual problem-solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. The zone of proximal development defines the functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in embryonic state. These functions could be termed the 'buds' or 'flowers' of development rather than the 'fruits' of development.

There are profound implications for educational practice in distinguishing the proximal from the achieved state by the clear method of contrasting assisted versus unassisted performance (Brown and French, 1979). For it is in the Zone of Proximal Development (ZPD) that teaching and learning occur. Instruction plays an important part of development (cf the point made in 1.1 above) when it can bring to life those functions that are in the process of maturing.

Cole (1985) argues for the key importance of the ZPD as the locus for the transmission of cognitive skills in a culture. Jahoda (ibid) wisely questions whether all kinds of cognitive advance take this cognitive form. He points to the need to account for active 'constructivism' by the child in trying to make sense of his world, and as well as for accounting for individual spontaneity in the absence of an adult, or more able peer. However, recent work on the ZPD (Griffin & Cole, 1984, Newman, Griffin and Cole, 1984) has gone some way towards obviating such objections. It may be, however, that what will ultimately be required is a full theoretical account of the co-ordination of the intrinsic and extrinsic generative mechanisms in the Zone of Proximal Development. To our knowledge, the specific application for paired learning which is indicated here has not been put into practice, at least not in an African context. However, a non-formal situation of mother/teacher and child dyads has been closely examined in the Zulu situation, by researchers at the University of Natal, Durban.

In the first study , part of which we will examine, Craig (1985) developed a conceptual framework for the study of change. She chose Zulu actors who are participating in WUIST-society, as a vantage point to describe one moment in change. Another vantage point was the Vygotskian formulation of regulatory mechanisms for psychological development (and specifically, a reformulation of Feuerstein's (1979) deficient cognitive functions.)

She then analysed the mother-child dyads in a problem-solving situation.[7] She applied the indigenous theory of childhood that she constructed, together with the ten mediational operators to her dyad-interaction data base in her analysis of change. Hers is an ingenious but highly theoretical enterprise, and we only describe one part of it below.

2.7.2 Ten mediational operators for problem solving in the Zone of Proximal Development

We will be discussing the work of Feuerstein directly in the following chapter. What is important to know about him now, is that his work on "mediated learning experience" can be seen as a descriptive explication of the Zone of Proximal Development. Feuerstein developed a great deal of clinical insight during his work on the development of assessment techniques and the development of an intervention programme for so-called retarded performers.

The children with whom he was working were North African Jewish children whose performance on standardised conventional intelligence as well as Piagetian tasks, was well below normal. Feuerstein felt that these measures did not result in a true assessment of the children's intellectual potential. Like the children studied in the Threshold Project, these children could be seen as competent members of their own milieu, but "incompetent" in terms of the demands of other settings. *It must be possible for children in such settings to change.*

Feuerstein stressed the importance of effective early mediation: the products of a lack of mediated learning experience are captured in his concept of deficient cognitive functions. He discusses the deficient functions at the input, elaboration, and output phases of what he refers to as the cognitive act. He also mentions affective-motivational factors that may contribute to poor performance.

What Craig did was to clarify the functions and reconstruct them in positive terms so they could serve as mediational operators which she construes as components of an ideal instructional process. Her argument is: if these mediational operators were present in the instructional process between mother and child, they would provide the occasion for the development of efficient autonomous problem solving skills in the children.

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7 The dyad's task was to copy three different models (pictures of these are to be found in the Appendix). The three puzzle-like tasks embodied some of the essential components of formal western schooling, including using as model as a source of information (reading and writing), integrating and co-ordinating different sources of information, and coping with an unfamiliar task under adult guidance. The exlicit task of the mother was to help the child to do the task.

The mediational operators are essentially inputs controlled by the mother. They have aspects of problem solving and heuristic strategies which we shall be discussing in the following chapter. They are organised from the most immediate and specific to the more abstract and general.

1. *Task readiness*. Task readiness refers to the willingness or eagerness to engage in tasks. It is important that the child should be ready to engage in the task, but also that his engagement should be sustained in an active attempt to solve problems.

2. *Gathering appropriate information*. The essential features of the task must be conveyed to the child, in a manner that he will understand. If the child gets fragmentary and isolated information he will be encouraged to follow blindly the instructions the teacher gives him. He needs to get the perspective of relating one bit of information to the task as a whole.

   This mediational operator is profoundly important as it emphasises the necessity of pursuing the inherent structure of the task in order to solve the problem situation. As Craig (p.223) says, " a child that understands the necessity to pursue evidence that will reveal the structure of a task has mastered an important aspects of efficient independent problem solving". The child will need to acquire appropriate strategies of information gathering.

3. *Specifying means and goals*. There are various aspects to specifying means and goals. The child should be made aware of a means and goals hierarchy (that is, some things have to be achieved before further goals can be attempted), and be equipped with the need to seek relevant information towards achieving specified goals. Specifying means and goals to a child highlight the fact that problem solving entails an ordered sequence of events. The child should be equipped with strategies to follow plans of action in executing tasks; this is an important aspect of problem solving as it allows the participants control over their goal directed activity. 8

4. *Making the problem explicit*. The child should be able to appreciate the nature of the problem before attempting to engage in task-oriented behaviour. One should make explicit to the child the task as a whole and that different facets demand specific responses.

5. *Attending to detail*. If the mediator describes the details of the task clearly, this highlights for the learner the necessity to be precise. This is especially important for complex problems.

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8 It is entirely possible that Craig has simplified here what is a critically difficult action for the child to perform. In section 3.4 below, we will see that specifying means and goals does not <u>per se</u> allow the child to *use* plans of action in task execution.

6. *Visual transport*. This ability allows the child to mentally transport missing parts over a general distance, or choose complementary missing parts from a number of alternatives. This frees the child from unnecessary motor activity during problem solving (especially of the trial and error kind).

7. *Emphasising invariant aspects of the task*. It may be very important for the child to perceive variation in given attributes as irrelevant to the identity of the object. If the child cannot maintain identity under transformation, he will not be able to penetrate appearances or discover underlying structures. The mediator can reveal a world of invariants across transformations, by focussing on and expressing constancies of elements across variation in attributes.

8. *Dealing with different sources of information*. In doing a task, the child will have to be able to integrate information from various sources, for example, in this particular instance the mediator, the model, the pieces, the template, the instructions, and the research assistant.

9. *Discovering causal relations*. The child needs to learn how to appreciate the possible effects of actions on objects and objects on objects; this will allow the child to understand the possible consequences of actions and emphasizes causal relations. The child will also need to discover that hierarchies will also have consequences. The opposite of discovering causal relationships may be regarded as trial-and-error or random behaviour. A instructional process that doesn't mediate the essential features of the task (cf. 3 and 4 above) to the child may encourage random activity on the part of the child.

10. *Co-ordination and integration*. Craig points out that this operator is actually the superordinate aspect of the total instructional process. In fact she equates the synthesis between bits of information and the order inherent in the task as a whole with Piaget's assimilation and accommodation.

These operators that Craig constructed were derived from Feuerstein's data that essentially made reference to adolescent learners; nevertheless the operators could have specific exponents that are possibly applicable to different developmental levels. Significantly, apart from (1), affective-motivational factors are conspicuously absent.

Craig may well have over-estimated the similarity of these tasks to typical school learning tasks. Learning to read and write may essentially be conceived of as problem solving tasks, but much of later "content" learning is not construed in problem-oriented terms or praxis. Hence deficiencies in these mediational operators may not be so readily apparent in pupils' performance until they do higher level mathematics, science, and geography etc (cf the discussion on inert learning in section 3.4 below).

However, to be fair, we should show how these mediational operators could apply to a classical school task - let us take learning to do long

division. For example, (i) the teacher could motivate the child for the need to solve higher order problems e.g. perhaps a bag of toffees amongst a class of 37 children. (ii) She would have to get the child to understand the concepts (albeit implicitly) of divider, dividend and quotient. (iii) She could show the child that we can make estimations, for example dividing by 4 and multiplying by ten, and that we need to find absolute answers, moving remainders up one place value. (iv) The child would have to realise the necessity of being precise (for example in laying out the problem), otherwise the results could be of completely the wrong order. (vii) The child has to be able to manipulate place value in a way that is alarmingly complex ... and which is therefore likely to be done mechanically.

What is important about Craig's data was that she was able to find instances of all these operators in her data; in other words, the mother/teachers were making use of what she considered to be necessary strategies towards the development of autonomous problem solving, but there was an "inefficient" use of these (Kok, op cit, p.5). It was this observation of poor performance that prompted further investigation and attempts to make sense of the video data.

The assumption of poor performance is based on an ethnocentric point of view and is only valid when evaluated from the analyst's perspective. The mothers and teachers engaged in the task and provided instruction in a way which was meaningful to them. It would be wrong to simply conclude that they simply performed poorly; rather, one must assume that their performances are guided by explicit rules for being which are based on their way of viewing the world and construing reality. So what Kok did was to reconstruct what the mothers and teachers intended in the execution of tasks, taking into account <u>their</u> rules for being.

In order to do this Kok used Craig's indigenous theory of childhood (cf also the description of this in School-Based Learning Experiences Final Report) in order to explicate the actors' rules for being. Kok tried to derive a set of mediational operators that would reflect the implicit expertise of the mothers in terms of their understanding of "silent" and "hidden" rules for child-rearing. So, these mediational operators, presented below, are a set of likely generative mechanisms in the Zone of Proximal Development that may explain the actions of mothers and children as they engage in the tasks. This set of mediational operators, derived from a process of rational reconstruction, is open to a continuous process of revision and modification.

It is most important to notice that the origins of the two sets of mediational operators are quite different. We have seen that Kok tried to predicate her set on the actors' rules for being. However, Craig derived hers from Feuerstein, a skilled clinician in the Western tradition, who, not serving in a capacity of a cultural actor, may not be representative as a source of rules for child-rearing. His perception is more oriented towards an "objective" conception of cognitive operations. Hence it would be unfair to make a direct comparison between the sets. However, what we can do is to work out what Craigian operators would be inadvertently obviated in the indigenous setting. <u>It is in the gap be-</u>

<u>tween Craig's and Kok's mediational operators that a new educational Zone of Proximal Development would have to be constructed</u>.

2.7.3 Six indigenous mediational operators in the same situation

(a) Maintaining mutually exclusive role division/exercise. This mediational operator refers to the joint task of the participants in the problem-solving situation of monitoring the boundaries of each participant's respective exclusive role and acting directly within the confines of the prescription of their own role exercise.

The task is construed in terms of social motives and goals (cf (f) below) so that the focus of instruction is to teach the child to solve problem <u>with</u> people rather than independently. The problem-solving situation would appear be defined as an instance requiring a collaborative and reciprocal <u>modus operandi</u>. The role of "teacher" and that of "learner" must be mutually exclusive and complementary. The teacher in this situation operates on the premiss of being the "one who knows", while the learner is cast in the role of the "one who does". The goal of regulation is to teach the child to subordinate individual intentions and desires and to become responsive to outer-directed instruction. What is learned therefore are ways of generalising the anticipation and reception of instruction to other situations.

The mediational operator involves several subordinates rules for problem solving. First, instruction given by the teacher is formulated around "guides for action" in order to allow the learner to do or act. The learner must be taught to respect the teacher and her role, the fact that the teacher is the "one who knows" or who is the appropriate source of relevant information. The learner must also maintain the role division and only act insofar as this will elicit further guides for further action.

COMMENT: In Craig's system, the roles would be complementary too, but the teacher would be the facilitator rather than the controller. The teacher is the one who both knows and does, and the learner is the one who does and thereby knows. The teacher is the one who knows, but she is not the only source of relevant information; in fact, the child can generate this information for himself. It is characteristic of authoritarian structures (for example, including the education departments) that they control the flow of information and knowledge strictly in accordance with rank. This attrition of information down the chain of command is something which we observed in the circuit context, while trying to arrange in-service training.

(b) Emphasising the manifest task demands. This mediational operator refers to the teacher's apparent assumption that the outward appearance of the task is the appropriate focus for the regulation of the child's actions towards successful problem-solving. This

mediational operator ensures the maintenance of the first operator described above: if there are mutually exclusive role divisions, then instruction emphasising manifest task demands do not provide sufficient information for the learner to complete an element of the task independently and ensures that the teacher's role in co-operative problem-solving is protected.

The teacher's primary goal is to elicit limited action responses on the part of the child: she emphasises aspects of the task which define its outward form. For example, the child will engage in an action response to the prompts such as "see", "look", "find one", "take another one". Then the teacher can give more direct guides for further action. These more direct guides are usually affirmations or negations of the child's actions, and less frequently make reference to more explicit cues, which the child could interpret as referring to specific pieces.

The teacher, whose role it is "to know", plans the problem-solving operation, notices the relevant relationships between elements, makes the appropriate comparisons between task and model, integrates the necessary information, scans for the detection of errors and generally co-ordinates the activities. She does not draw the child's attention to these strategies or provide instructions that would engender the acquisition of these skills in the child as it is the child's task to carry out limited action responses on the basis of manifest cues in the problem solving situation.

COMMENT: It seems that the focus is on the outward appearance of the task. Here we would refer to the possibility that sometimes the forms would be opaque to teachers, and therefore they themselves can only mimic surface characteristics of the task. The teacher may not be used to bringing to the surface deeper aspects of task performance if it requires a mode of consciousness which she is not adept with. We refer back to 2.3.3 where we saw the Standard 3 children characteristically unable to get below the surface structure of the tasks they were given: perhaps their teachers never help them to do this. While teachers may not think it is appropriate for children to do certain "advanced" things, the obverse of this is that they do not believe that the children could do these things. We refer in our School-Based Learning Experiences report to the fact that it was previously not thought that children could learn their whole alphabet in Grade 1, and now it is known that it is possible to get them to read connected discourse fluently. (The Grade 1 children used to spend a goodly portion of their time jumping up and down shouting "a","a","a" ....)

(c) Embedding instruction in a know-how (practical) paradigm. This mediational operator emphasises learning through doing and instruction based on creating opportunities for action. It is the teacher's task to gather the necessary information, understand the problem, discover the essential relationships, plan the appropriate strategies and co-ordinate and integrate the exercise. The child's complementary role involves learning to carry out the appropriate actions to complete the task.

It is incumbent upon the teacher to provide instructions which create opportunities for the child to discover what to do, without imparting the knowledge which falls within the realm of her exclusive role exercise. In order to achieve this goal, the teacher creates opportunities for trial-and-error behaviour on the part of the child; she allows attempts that may have been prevented, rationalised or made more efficient, not being concerned with means-end efficiency. When the child makes errors due to incorrect cognitive planning (part of the teacher's domain), she is not corrected. However, the child is encouraged to assess incorrect actions. When verbal instruction does not result in appropriate action responses, the instructional modes frequently used by the teacher are demonstration and example, while observation and imitation are the parallel learning modes emphasised by the child.

COMMENT: It is this operator that will directly conflict with the use of five of Craig's ideal operators, and therefore will have to be addressed the most closely of the operators in any model of constructive change. For example, the child is not expected to be able to participate in the gathering of appropriate information; he does not have the essential features of the task conveyed to him, and cannot pursue the inherent structure of the task. And if the child is going to be part of specifying the means and goals of the task, he will have to understand the structure of the task. If he does not have the problem made explicit for him, then he will find it difficult to know which part of the task to pay specific detailed attention to. Invariant aspects and causal relations will become more difficult to discern. If the child does not get significant feedback on the consequences of his actions, then, at a deep level, he will fail to learn.

(d) Embedding instruction in a know-it (experiential) paradigm. The teacher emphasises generating efficient, synchronous action on the part of the child, in response to minimal cues, by encouraging the development of intuition and sensitivity to the other person's unexpressed intentions and plans; the child has to learn to respond to minimal verbal cues and attend to non-verbal cues such as gestures and visual focus. This inhibits the child's individual impulses and intentions to independent action.

When verbal instruction based on minimal cues does not elicit an appropriate response, the teacher frequently uses non-verbal cues e.g. pointing, gesturing to or manually manipulating the child's hand towards the position/piece intended for selection or placement. It is important that the child respond immediately or appropriately, more important in fact than satisfying the task demands of exact model replication: erroneous experience is not considered valuable in the attainment of this synchronous transaction.

COMMENT: Craig makes reference to the child's need to deal with different sources of information: in this instance, the child is dealing with different sources of information, but they are most conspicuously on the social level, and here the most important source of information, is once again the teacher. The child's individual impulses to independent action are indeed there, but they are being systematically inhibited until per-

haps, later, they cannot easily be activated. If one's impulses to independent action are sufficiently thwarted, then it probably follows that one's impulses to independent thought are going to be too; and to this we would add that we do not know what the consequences for independent consciousness would be.

(e) Providing an accepting environment for guided discovery. In this operator, the teacher tries to reinforce the child's engagement in the task, on the assumption that creating an accepting environment is appropriate and conducive to learning. A warm, tolerant and accepting learning environment is created, and the teacher frequently reinforces the child's reactions to instruction regardless of whether the reaction is correct or appropriate. As the situation is construed in co-operative interdependence, the learning situation lacks the more focussed, demanding and task-focussed atmosphere desirable in a situation where the primary goal is precise and independent problem-solving.

COMMENT: Here we have an operator which we have readily identified in our ethnographic project work. In the PEUP grades classrooms, we have seen many motherly teachers, radiating warmth and tolerance. The capacity for the social aspect of the child-centredness is clearly marked, while the absence of a demanding task-focussedness is equally marked. However, tolerance towards the child as a learner, and a capacity to generate focus on specific aspects of tasks that need attention are not mutually exclusive qualities; it is the other mediational operators (a, b and d) that are preventing the two from co-occurring.

(f) Construing the task in terms of social motives and goals. This mediational operator is the superordinate aspect of instruction. the successful outcome of the application of the abovementioned operators. It refers to the primary goal of all regulation: that of learning to do tasks with people and subordinating individual intentions and desires to social motives and goals.

The first prerequisite for learning to proceed is that the child learns to respect the teacher: the teacher is the appropriate source of information who will provide appropriate guidance for action. Secondly, therefore, the child must be taught to subordinate his independent plans or intentions for action to those of the teacher and to simultaneously learn to respond appropriately to the teacher's instructions.

COMMENT: This operator is the parallel of Craig's higher order operator of co-ordination and integration. However, in this instance, the goal would be social rather than cognitive adaptation. It may be that to some extent these goals are mutually antagonistic. From the work done by Craig and Kok, it would seem that the primacy of the social over the individual leads to deficient functions of autonomous problem solving.

What has been observed here on the dyad level and so carefully described can be recognised in the larger context of class teaching. For example, the role division is very strongly maintained. The teacher is "the one who knows" and the child learns to become responsive to his instructions. In many cases the teacher only gives piecemeal instructions and have children waiting for the next part-instruction. The children are sometimes given rather dubious feedback about the effectiveness of their content understanding or learning. It is very important that the children should "be with" the teacher (paying attention), even if they do not understand. The teacher of very young children provides an accepting environment for the young child, although this alters as the child grows older for reasons that are not entirely clear.

This research reviewed in this section is the most important in this chapter from the point of the view of the Threshold Project, specifically the contrast between the ideal and indigenous mediational operators. The challenge for us is to conceive how the transition from the one to the other can be constructed, without rupturing, as it were, the indigenous Zone of Proximal Development, and without leaving the teacher disempowered as an educational mediator.

The two types of mediational operators, separated by their own ZPD are reproduced below at Figure 2.7 so that we can look at the differences at one glance.

The first perusal will show that the "social" aspects of learning appear to be pared away in the right column. Yet the ideal operators were also operating in a fluid, interactional system of cognitive support that Wood, Bruner and Ross (1976) call scaffolding. (The scaffolding is a matter of social relations as well as of subject matter content.) In this game-like format, the learners should have considerable right to help to shape the task. However, in the present studies not much was said about the child's shaping the task, but a great deal may be inferred about how the adults were shaping the task. At the risk of overgeneralising, the indigenous operators serve to keep implicit the underlying structures of the task, while the ideal operators serve to make explicit the underlying structures of the task.

There is further crucial data missing in our comparison of the operators. In the case of the "ideal" operators we don't have rational reconstruction of WUIST data on what such mothers and/or teachers would have intended in their execution of such tasks, taking into account their rules of being. What seems to be missing from Craig's ingenuous construction of these operators is a theory about the child-actor as a learner; we don't have a clear picture of what the role division or sharing would be, what the expectations of the child are, apart from being an active participant or (to extrapolate further) having a genuine contribution to make to the solving of the problem as such.

To speculate further; we said above that the third indigenous mediational operator - embedding instruction in a know-how paradigm - would be in direct conflict with many of the ideal operators. On Kok's interpretation, it is the teacher's task to gather the necessary information, understand the problem, discover the essential relationships, plan the appropriate strategies and co-ordinate and integrate the exercise: these five aspects are actively being withheld from the child, who furthermore is not given feedback on errors due to incorrect cogni-

"Indigenous" mediational operators		"Ideal" mediational operators
1. Maintaining mutually exclusive role division	→	1. Task readiness
2. Emphasising manifest task demands	ZONE	2. Gathering appropriate information
3. Creating opportunities for action or doing without fully knowing	OF	3. Specifying means and goals
	PROXIMAL	4. Making the problem explicit
4. Creating synchronous action in response to non-linguistic cues	DEVELOP-MENT	5. Attending to detail
		6. Visual transport
5. Providing an accepting (unfocussed) environment for guided discovery	IN	7. Emphasising the invariant aspects of the task.
6. Construing the task in terms of social motives and goals	FORMAL	8. Dealing with different sources of information
	LEARNING	9. Discovering causal relations
	→	10. Co-ordination and integration

Figure 2.7 The two types of mediational operators.

tive planning. We detailed some specific consequences in Craig's terms, but to extend our interpretation further here, we speculate that not being party to underlying structures of the task will in the end lead to an underdevelopment of the child's capacity for metacognitive experience and the learning of cognitive and metacognitive strategies (something which we ourselves documented in a preliminary sort of way). Erickson (1984) refers rather disparagingly to these mental capacities as "learning to talk in school-like ways" about their reasons for choices in experimental tasks; yet metacognitive "justifications," and "deliberate comments" are well-documented effects of schooling (e.g. Cole and Scribner, 1981). Our interpretation would be that such outcomes would most conspicuously manifest themselves in contexts where the ideal operators are enabled to function.

At the risk of inventing another "I", one might posit some "intermediate" mediational operators for use in the current educational ZPD. The

first one would be *give the child autonomy and responsibility for part of his learning task;* being part of a child-centred philosophy, the operator has been developed in the PEUP. The corollary of this would be *create opportunities for the child to act with a measure of understanding* (the conditions for this will be developed below). This will be partially achieved if one creates a *task-focussed atmosphere.* The task may be construed as co-operative, but *achieving autonomous success on tasks should become ends in themselves.*

These intermediate operators the teacher can create herself; however - and crucially - the ideal operators will be mediated by the tasks themselves.[9] The tasks will mediate to teacher and child alike. They will do this by carrying explicitly within themselves questions and directives which function specifically like these ideal operators, for example,

1. Gathering appropriate information could be done by the use of advance organizers, visual, oral or written (cf. Spinelli and Siskin, 1987, for examples to be used in the second language reading situation).

2. Questions asking children to relate means and goals.

3. Descriptions of the problem and perhaps cognate problems.

4. Directives getting the learner to focus on important details.

The materials would have to be strongly activity-based, getting the learners to actively participate with the text, best realized as a workbook. The task can then be objectified as a process mediated through the materials, with the assistance of the teacher as co-learner, then facilitator.

We have taken our projection of the Natal data to an initial point on the basis of their basic interpretations. We would like now to return to the larger context of the discussion of this chapter, to set some of the parameters which have arisen from it.

2.8 CROSS-CULTURAL COGNITIVE DEVELOPMENTAL PSYCHOLOGY AND THE CURRICULUM

In the last section of a very long chapter, it would not be appropriate to try to summarise the main points that have been made. Rather, this

9 Although the concept of the task mediating is implicit in Craig's writing, I should like to thank both Craig and Bentley for suggesting that this should be a salient part of our solution.

section points forward, to the fourth and final chapter of the report, where we try to develop a model for considering development of thinking skills within the curriculum. Hence, what we attempt here, is to point out those principles that have emerged as viable for such an enterprise. In order to guide the reader, the principles will be extracted in the same order as they were discussed and then a general model presented i.e.

1. Piaget

2. IPS approaches and metacognition

3. TCO (Theory of Constructive Operators)

4. Rational model theory

5. The Vygotskian and neo-Vygotskian paradigm

6. Threshold Project Research

7. A model for the study of the child and the developing curriculum

1. Piaget

From Piaget we learn that we have to have a theory that accounts for adaptation to our environment. Piaget has given us two intrinsic generative mechanisms for change, i.e. accommodation and assimilation, which are co-ordinated by equilibration. However, we have a problem in Piaget's account for how disequilibrium arises in the first place, and what the mechanisms for changes as part of equilibration really are. Cross cultural research shows that not all his posited stages are achieved, in particular formal operational thinking. However, we do know that some aspects of school learning require formal operations. In other words, we have to take some account of the necessity of developing hypothetico-deductive thinking.

2. IPS approaches and metacognition

IPS approaches provide useful languages for characterising cognition. (For example, flow diagrams represent hypotheses about the temporal nature of cognition.) They have different kinds of representations that can be used for representing different kinds of knowledge: for example, semantic networks for declarative knowledge, and production systems for procedural knowledge.

The mechanisms for development which are posited in this approach are self-modification (reminiscent of Piaget's assimilation and accommodation), which include consistency detection and redundancy elimination; automisation, in which the functional working memory executes the operations characteristic of a stage more efficiently; and encoding and combining. None of these mechanisms are entirely adequate at an explanatory level, as they stand.

Metacognition or executive control has been singled out most especially in recent years for research, but there is a certain fuzziness in the use of the term. However, it seems to be useful to make a distinction between metacognitive knowledge, metacognitive experience, and cognitive strategies (skills) and metacognitive strategies. On a classic model, metacognitive knowledge serves as a base for metacognitive experience (consciousness), which triggers the use of strategies. The literature would seem to indicate that young children would still be in need of developing metacognitive knowledge, since they do not often report metacognitive experiences, and they are likely to suffer a shortage of strategies (both cognitive and metacognitive). For our purposes, we do not yet know the range of metacognitive and cognitive strategies which are required in junior primary education, and how these match with the children's competence.

The particular appeal of the IPS approach is the possibility for doing very explicit research on complex processes like reading and writing. Cognitive modelling should yield insights for language teaching.

However, the IPS cannot explicitly take account of the social context in the broadest terms, nor of mediation in specific terms. This observation would be true of all central processor theories, including the work of Piaget, IPS approaches, and Pascual-Leone.

3. The Theory of Constructive Operators

Pascual-Leone, in his Theory of Constructive Operators (TCO) gives us an explanatory account of equilibration, how and why the organism needs to undergo structural changes. Although the evidence is not unequivocal, it seems reasonable to accept a stage level theory that could be defined in terms of information processing capacity.

The TCO emphasises the need for a bilevel system of cognitive operators i.e. subjective operators (content specific schemes) and silent operators (content free schemes). The conceptualisation has important consequences in being able to account for qualitative changes in the development of thought.

There is also the productive distinction made between mental capacity and learning, which can help us to distinguish between development and learning factors. (However, the nature of his classical experiments gives us no clear indication towards facilitation in terms of learning.)

4. Rational model theory

Miller extended the work of Bhaskar in analysing the relation between the individual and society, of culture and mind. He makes the distinction between the individual and the actor, social forms and the group. One is able to distinguish between competence as an actor being part of a social group, and competence as an individual, participating perhaps in different social forms.

There are two necessary moments in a general theory of change i.e. socialisation - when cultural (extrinsic) mechanisms are imposed upon

individuals and regulate their intrinsic generative mechanisms; also, transformation which operates when the individual (with his intrinsic generative mechanisms) exerts an influence on social performance. The generative power of transaction acts as an overarching constraint in the interpsychological space.

From our perspective, we would be interested in how cultural mechanisms operate to produce specific cognitive products that are only in varying degrees adequate to the demands of what we have called WUIST-society. We need to be able to establish what the optimum conditions are for cultural transaction to accelerate change which is undoubtedly already taking place.

5. Vygotskian work

In this paradigm, which we have partly anticipated in the previous section, we have learned of the key concepts of mediation, specifically in the Zone of Proximal Development (ZPD) the difference between development and learning, and learning and teaching as it takes place in the ZPD. The research conducted at the University of Natal has made a vivid contrast between "ideal" mediational operators, which being Western, are essentially oriented to autonomous problem solving, and indigenous mediational operators, which are more socially oriented, and do not facilitate the development of autonomous skills, focussing rather on the co-operative and the complementary.

In using this paradigm, the challenge for us is how to effect a change in learning styles, when the teachers, intentional purposive behaviour is generated by her beliefs, values and norms. Craig has noted the importance of the adapting and adapted systems to interact (i.e. black and white education), so that their norms may become less opaque to each other. However, we would be concerned that such an interaction should not take place within a value-laden context, where long-standing feelings of inferiority might simply be reinforced. The possibility of using tasks as mediators to a new cognitive reality for both teachers and pupils might well be explored as the most viable option.

6. Threshold Project Research

At the beginning of the project, we decided to use a neo-Piagetian model of cognitive development as part of our cross-cultural research exercise. Accordingly, we used Le Bonniec's Theory of Modal Reasoning, which is predicated on the notions of possibility and necessity. Le Bonniec felt that Piaget underpredicts what children can do, and indeed she is able to demonstrate their using hypothetico-deductive thought well before adolescence. Unfortunately, using her Box and Circles Task opened us to criticisms levelled against orthodox experimentation in a cross-cultural context: we were failing to get at indigenous modes of thinking in everyday contexts, on the one hand, and on the other hand, we were not exploiting the situation to identify the mediational operators the child would bring to a WUIST-type task.

However, we were more concerned about how the children would perform on tasks which they would have to perform, i.e. school-type tasks. On two

very simple tasks which we designed we found that children were not easily able to make explicit to us their thinking operations (i.e. their metacognitive experience) nor were they able to supply what might have been construed as "logical" explanations for their decision making. It seemed to us that there was a distinct difference between the Batswana and the multicultural groups that we tested, but we do not know what the fullest educational implications of these findings would be. It may be that in the broadest sense, the children are learning to approach problems without a great deal of consciousness of self, and in the long term, higher order problems approached in the same way would seem quite inexplicable and opaque to such learners.

G. A model for the study of the child and the developing curriculum [10]

As part of the larger enterprise of the Threshold Project, we see a definite purpose in the conceptualization of further research within a coherent paradigm. Too many tired syllabus revisions pass as curriculum development, partly because they are not informed by coherent theory, a coherent concept of the child in relation to the curriculum. What follows below has all been addressed implicitly or explicitly in the course of this chapter, but a rigorous description in theoretical terms is attempted.

In Bhaskar's (1979) transformational model of the relationship between the individual and society, he refers to the fact that there is an ontological hiatus between society and people, as well as there being a mode of connection (transformation) between them. Miller (1984) elaborated a mode of connection in a "third" dimension in which social forms are conceived of in terms of the relationship between depersonified actors and groups conceived of as a plurality of individuals. His model is dialectic, the dialectic residing in, for example, the process whereby an individual engages in a role prescribed by social forms. The analytical entities - social forms, roles, individual forms, and actors achieve empirical realisation in the mind-culture action dialectic. The mind/culture dichotomy is avoided.

In trying to elucidate the study of the mode of connection between the individual and society, one has to distinguish between:

- the levels of analysis;
- the analytical entities (mentioned above), and
- the empirical manifestations of the object of study.

To look first at the *levels of analysis* possible for the concepts in the 'individual/child' and 'society/curriculum', it is productive to distinguish between the *descriptive* and the *explanatory* levels. Explanation can be pitched at the level of *generative mechanisms* of change which might be extrinsic or intrinsic. (For example, Piagetian theory is a

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This section has particularly benefitted from a study of the model which Craig (1985) developed for her research. Any false analogies are of course, my own responsibility.

coherent account of the intrinsic generative mechanisms for the development of mind; Vygotskian theory is an account of the extrinsic mechanisms for the development of mind.)

Explanation may also be cast in terms of *reasons* at the psychological level, where reasons have a causal function (in particular allowing for a notion of agency at the psychological level, a notion which cannot consequently be reduced to a physicalist level). When analysing "reasons as causes" Bhasker (ibid) argues that reasons should not be reduced to physical states, but should be understood as being circumscribed by social conditions.

A more complex model for analysis is that proposed by Pascuale-Leone (pers. comm., 1986, also in Craig, 1985), a model which posits the need for analysis at five different epistemological levels:-

1. the "objective" - the descriptive account of the manifest behavioural phenomena;

2. the "phenomenological" - an account of the task from the subject's point of view;

3. the "subjective" - the structuralist aspect of the organisation of schemes, as well as the process structuralist aspects, in which real time is introduced in the operation of schemes;

4. the "ultrasubjective" - the notion of executive schemes operating on action schemes and

5. the "metasubjective" - the development of appropriate action and executive schemes through the action of silent operators. Generative mechanisms operate at this level.

What is challenging here is that one could perform an analysis of a school task or situation at each of these epistemological levels. In fact, we will not fully understand the nature of school learning, and the demands it makes on the child until we can give an account of it at all these levels. Obviously there is a developmental aspect to the description of all these levels.

To look at the *analytical entities:* the 'curriculum' could be seen as an intensified, perhaps objectified version of society transmitted as existing social forms and knowledge about the world, but at the same time, the social processes underlying cognitive development. Pre-existing social forms and the social processes (e.g. teaching) through which these constraints transmitted to the child demand cognisance of the Vygotskian paradigm. However, we need to be able to escape from the equation of the curriculum and society, because implicit in the dynamic equation of the curriculum and society is the transformation of tasks as they have notion of the curriculum is the transformation of tasks as they have been conventionally conceived in the natal culture (cf. the description at 1.3 above).

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The developing 'child' represents a conceptualisation of those powers of people which enable them to act and become actors (Harre and Secord, 1972), and is explained by intrinsic generative mechanisms (as for example, in the Piagetian model, remembering however, that he does not give an account of the acquisition of cultural, but scientific, knowledge). The 'roles' that the child plays are those slots that the child slips into in order to reproduce the social structure. The slots may be conceived of as available means for action. The child in action becomes an 'actor'. When the child acts, the analysis of the 'performance' must unite the psychological and the social domains.

The last analytical entity for description is 'individual forms'; here the functional structures of mind are the focal point. 'Individual forms' refers to the psychological mechanisms (levels of schemes) which may be assumed to generate intentional goal-directed behaviour (praxis). Intentional human praxis always takes place in a social context, and that is why we need to introduce the notion of extrinsic generative mechanisms in the study of the child in a learning situation.

To look now at the empirical realisation of the analytical entities, what we will see is the child and adult in action in a specific spatio-temporal context. Action has the interface function of expressing and using social forms and individual forms. 'Society' and 'the individual' unite in expression in action. The individual both exercises and translates social and individual forms; in action, "transformation" and "socialization" occurs.

This paradigm attempts to move away from what Vygotsky calls the "stimulus-response framework" (1978, p. 58) of considering mind as a function of culture. For Craig the mind-culture action dialectic is an expression of the idea that mind-in-action and culture-in-action each instantiates the other. So instead of the question (Sternberg, 1982 p.542):

    How do the differences in culturally organised experience affect
    the development of powerful and efficient problem-solving skills?

Craig has formulated a new question:

    "What are the enabling conditions for intentional and meaningful
    action?"

She conceives of the enabling conditions as the generative mechanisms. The extrinsic and intrinsic generative mechanisms are regarded as co-determining change or development. With reference to the particular mother-child problem solving dyad situation which Craig studied, she invokes the notion of an exchange system; this is created between on the one hand the two participants engaged in the task, and on the other the task and any one or both of the participants. Her empirical data reflect two types of adaptive processes: children who adapt to whatever reality the mothers construct for and mediate to them; and mothers who have adapted to a known reality and who are also in a process of adapt-

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ing to an unfamiliar reality. Extrinsic adaptation occurs in the task situation including re-definitions of the tasks, restructuring of the instructional process, and re-interpretation of the role of teaching or teacher. The task demands engagement in terms of its own (western) social meaning or culturally autogenous development and the actors participate in terms of their own social and psychological development. From action a dialectic emerges between the actor and the task, between one historical tradition and another from which a new synthesis must emerge which cuts deep into both individual and social change.

Looking at our broader problem area, Craig says that as a socialising agent schooling meets the demands of western society and may produce changes in the cultural traditions of those who participate in the formal school system. But the cultural forms that the participants bring into the school system may in turn change that system and transform the nature of its supporting roles and tasks. (We saw an instance of the adapting system changing the adapted system in the implementation of "child-centredness" in the PEUP, where the construct was "indigenized" - see the School-Based Learning Experiences Final Report.)

The fact that people do engage in available roles and tasks and do resolve the problems of unfamiliarity is the primary empirical data: however, one needs to account for the genesis of change. The mother in the situation must, in her own adapting, provide the children with the learning experience necessary to adapt successfully. Here the notion of the Zone of Proximal Development may be called into play. Craig says (1985, p.292):

    The explication of the Zone of Proximal Development may provide a
    basis for understanding what must obtain in the instructional
    process or the process of mediation in order for the adapting sys-
    tem [the child to developing efficient autonomous problem solving
    skills or abilities.

Concepts which are helpful in explicating the notion of the Zone of Proximal development are for example when the mediator changes her definition of the task or of the situation. What we would be interested in is the occasion when the task is able to change the teacher's definition of the situation.

Craig is concerned to give an explanation of the dynamics that regulate the transacting systems that co-determine change in the ZPD. The system may confront a problem in a conflicting or non-conflicting manner in terms of the discrepancy or similarity between the problems and system resources. Hence we may get:

1. Non-conflicting confrontation between the problem and system resources

2. Conflicting confrontation between problem and system resources.

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Looking at the first situation, which is of critical importance in analysing the Threshold Project problem domain: an unfamiliar problem may be confronted without attempting to resolve the unfamiliarity but by attempting to change the task or problem in order to make it consistent with existing schemes, habits, knowledge or system resources. This can be illustated by assuming that teachers may treat problem-solving learning as if it were learning by imitation; in this case the teacher will fail to emphasise the discrepency between what the task actually demands and what the child's resources are, she will fail to present the task in a conflicting manner, and the child will fail to develop the resources for surmounting what is a genuine non-balance. Here we have the instance of a lack of adequate mediated experience: inadequate in terms of the task inherent demands (cf. the section on Feuerstein in the next chapter) - in what Craig has whimsically called "the zone of restricted development". In this zone, the mediator may provide the learner with a construction of reality that is antagonistic to the acquisition of new goals or competences or performances. Into this stalemate situation the twin aspects of change must enter - an adapted system (western education) socialising another (developing black education), and the adapting system (children) transforming the adapted system (their teachers).

Looking at the second situation, an unfamiliar problem or task may also be confronted by attempting to highlight or resolve the conflict between the demands of the task and the system's understanding of the task. In this case the role of the mediator may be that of presenting the elements of a task in a conflicting way in order to emphasise the discrepancies between the task and its demands and the system resources (schemes/structure/knowledge) for dealing with the task. An unfamiliar problem may thus be confronted through exercising the system resources in order to resolve the unfamiliarity. The adaptation involves either a re-combination of existing schemes in a new way, or where the scheme system transcends its own schemes towards adaptation, or where the resolution may actually change existing social forms.

The issue of how a system is made aware of the discrepancies between existing schemes, knowledge, or known actions and the demands of the task is the crucial one. It refers to what Craig terms the "generative power of transaction", and she stresses it is important to understand this transaction as possible between people and people, and people and objects. The task dictates its own resolution (may reveal its own structure), and so it provides a basis for change through action on it. Here we are able to extend the notion of mediation to mediation by the task. This would be required when the teacher, herself an adapting system, cannot convey to the child the culturally autogenous development of the task as an object coming from a different socio-historical trajectory.

We present below a model (Figure 2.8) for the possibility of change in formal learning situations which we have adapted from Craig (p.121), bearing in mind both the work of Kok, (1986) and also the discussions that we have personally had on this problem area. Implicit in this model is - quite clearly - further components of a research programme that has already been started for one purpose by the Natal group, but which could be constructively developed for the purposes of curriculum development.
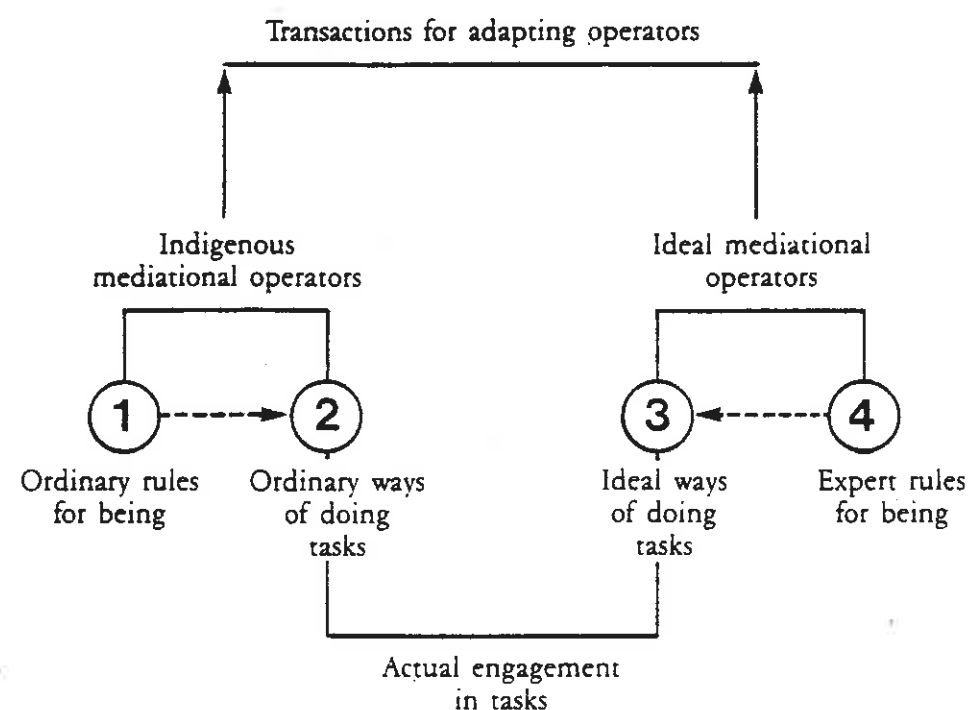
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Figure 2.8 Changing the mediational operators in formal learning (adapted from Craig, 1985)

This model tries to integrate what we discussed in the section above about the difference between ideal and indigenous operators, and show that transaction is needed between the two systems. Circles 3 and 4 would require further research in general terms. However, this model is a general one for "the task", and the task of the child develops in different ways during the course of primary school, and specifically in the course of second language learning. In Chapter Four we shall see how the tasks have been analysed in bilingual education theory. The task as it conceived of in this paradigm does not simply consist of the description of the manifest performances; rather the underlying logic of the task should be analysed, as well as the taken-for-granted aspects, which we only discover in analysing (perhaps black) children doing unfamiliar tasks: this is where the method of cross-cultural psychology can help in analysing tasks that are part of the everyday curriculum. What we also need to know then, in relation to the task, is what the learner brings to the task. In this way we can match the demands of the task to the resources of the learner.

An aspect of child development which has largely been neglected in cross-cultural psychology is that of affect. Jahoda (1986) reports that the field is in the early stages of development, but that workers such

as Harkness and Super (1985) call for the need for conceiving of 'cognitive-affective structures'. Although many psychologists have traditionally regarded affect as an attribute of individuals, it seems that seeking to understand emotions will involving understanding cognition, both being part of cultural constructions. Jahoda points out that emotional structures may be developed and learned in the same way as cognitive structures, and that emotional systems thus construed would include notions such as 'motivation'. This concept will, at face value, be of importance in an account of the child's learning and the adult's mediating, and would therefore have to be explicated, rather than simply mentioned in a coherent model. Emotions will become seen as part of the enabling conditions for intentional and meaningful action which Craig referred to; emotion and cognition will together become an intrinsic part of the individual's 'modes of being'.

In the development of a model, we will need (as we mentioned in the previous section) an account of how the learning/teaching materials mediate to the child as an adapting system, and to the teacher as an adapting and adapted system. In relation to the child, learning materials (as constituents of tasks) will have to mediate underlying abilities to the child and to the teacher. In addition the learning materials will mediate to the teacher a developing understanding of the nature of the problem solving/formal learning experiences. In evaluating the learning resources, we would have to assess how they approximate to the task they purport to constitute, the nature of the child's adaptation to the resources, the nature of the teacher's adaptation (both as learner and mediator), and what kind of motivational/affective structure can be developed through the resources.

In this last subsection of Chapter 2, we have tried to bring together concepts for a model for studying the child in relation to a changing curriculum. We have tried to show that such an enterprise will have to have an account of the analytical entities, levels of analysis, and the empirical manifestation of the phenomena under study. The core concept of mind-in-action, and extrinsic and intrinsic generative mechanisms accounting for change have been emphasised. Although this account is not specified in detail (in the sense that we have been able to do a task analysis of school learning), it does allow us to draw up a list of questions which we will be able to address to the "teaching thinking" programmes that are to be described briefly in Chapter Three:

1. How does the approach help us to understand the nature of formal learning?

2. Are aspects of cognition related explicitly to formal learning experiences?

3. What is the nature of the mediation implicit in the programme, both in terms of the teacher and the materials?

4. What are the roles expected of the teacher - how is her adapting expected to occur?

5. What are the roles expected of the pupil?

6. Is the intervention appropriate to what we know of the cognitive development of children in middle childhood i.e. including reference to basic cognitive operations, and emerging metacognitive skills?

FIVE APPROACHES TO THE TEACHING OF THINKING

These approaches are rather different in nature, so in order to orient the reader, a brief overview is given of each.

1. COGNITIVE OPERATIONS programmes focus on certain operations or processes such as comparing, classifying, and inferring. They develop and strengthen operations on the assumption that as a consequence, thinking ability will be improved in general.

2. HEURISTICS-ORIENTED approaches emphasise the teaching of specific methods, techniques or strategies for dealing with problems. Constituent methods include planning, problem decomposition, representation and solution checking or verification. They purport to provide the learner with variety of problem-solving strategies that are applicable across many domains and an understanding of the specific conditions under which the use of each is appropriate.

3. FORMAL-THINKING approaches have a Piagetian orientation; the assumption is that the primary reason why students entering college have difficulty with their studies is that they are stuck at the pre-formal stage of cognitive development. They provide types of training and experiences that are supposed to move students to formal operations. The principal mode that is employed is an emphasis on exploration and learning by discovery. The material progresses from the more concrete to the more abstract. Another characteristic is that the teaching of thinking skills is merged with the teaching of conventional course content.

4. THINKING THROUGH LANGUAGE (AND OTHER SYMBOL SYSTEMS) approaches emphasize language and symbol systems as media, not only for expressing the results of thought, but for thinking. They focus on symbol manipulation activities such as writing, analysing or composing arguments, and computer programming, and emphasize complex products such as prose composition and computer programs.

5. THINKING ABOUT THINKING approaches focus attention directly on thinking as subject matter. Students are encouraged to think about thinking, to learn something about the intellectual capabilities and limitations of people in general, and to become more aware of their own thought processes in particular. Some programmes emphasize the teaching of metacognitive skills involving conscious management of one's own intellectual resources.

In general the variability within categories is as great as between categories; the range of approaches that has been tried indicates the exploratory nature of the area.

This could be regarded as inevitable in the absence of a widely accepted theory of cognition from which prescriptions for the enhancing of thinking skills could be derived. To be more specific here, Piaget's work

has been on the developing <u>epistemology</u> of the child, and he did not claim "psychological reality" for his theory.

3.1 COGNITIVE OPERATIONS APPROACHES

3.1.1 The Cognitive Operations Approach in General

These programmes try to extensively exercise component cognitive operations out of which more complex activities are constructed. The component operations on which they focus are similar to what theories identify as constituents of intelligence.

The theoretical foundations of the first programme to be reviewed are problematic; it is easy to make up a list of fundamental operations and the "lists" differ considerably from one another. Another problem at the level of theory is the holistic treatment of components like classifying, which itself has complex application. It is not clear whether it is a unitary skill.

These programmes tend to neglect the most complex types of cognitive performance, ie writing or mathematics problem solving. Once the students achieve mastery of the basic skills, there remains the problem of handling more complex tasks. Cognitive operations approaches may be more appropriate for weaker students, who have not mastered basic skills, than stronger students, who have done so to a greater extent.

Characteristically they offer a great deal of practice with a diversity of cognitive tasks. The operations are viewed as problematic, and students are expected to need substantial practice. The amount of practice required may be hard to estimate, so the routine monitoring of the progress of students and supplying additional instruction as needed is encouraged.

Nickerson <u>et al</u> (ibid) stress that an approach to teaching that has weak or theoretically controversial base may be effective nevertheless. This is because:

1. the state of theory on <u>intellectual competence</u> is still weak, it could be a mistake to lend too much weight to analysis of underlying theory in assessing programmes;

2. even a theoretically questionable list of basic cognitive operations may include many of the activities students need to perform;

3. the list may provide a heuristic guide to constructing lessons, and

4. lessons promote the learning of a variety of useful skills.

Nickerson <u>et al</u> go on to say that some of the skills acquired may be different from those the authors of the programme imagined, eg. students may acquire cognitive style traits much more general than anything acknowledged in the curriculum materials.

We are going to look at two approaches in this section. The first is the Instrumental Enrichment Programme and the second is the learning of process skills. They both purport to directly teach cognitive operations.

3.1.2 The Instrumental Enrichment Programme

Amongst the best documented and most widely known approaches to the enhancement of cognitive performance is the Instrumental Enrichment Programme of Feuerstein, who was formerly the Director of Psychological Services in Jerusalem. His programme is based on the conception of intelligence that emphasises processes as opposed to factors or products, and grows out of a dissatisfaction with conventional methods of intelligence testing.

According to Feuerstein (Feuerstein, Rand, Hoffmann and Miller, 1980) intelligence is not fixed, but malleable: human beings are receptive to change and modification. In particular, it is a dynamic process that is responsive to external environmental intervention (the influence of Vygotsky, albeit unacknowledged, can be readily seen in different aspects of the approach).

Because of Feuerstein's interest in the notion of change, he searched for an instrument which would assess potential rather than absolute performance. If one believes in absolute performance levels, then psychometric test results will become self-fulfilling prophecies that doom many "different" learners to becoming "slow" learners.

The case against conventional standardised psychometric testing procedures has been put rather strongly (Feuerstein, Miller and Jensen, 1980, p.20):

> There is a real sense in which attempts to produce cognitive change while adhering to a psychometric conception of intelligence is an irrational endeavour. To ask how meaningful cognitive changes may be produced is tantamount to psychometric heresy because it is this question that undermines the entire statistical apparatus and conceptual foundation upon which the tests are based. It is difficult to conceive of an instrument that would satisfy the measurement requirements of predictability and modifiability.

There are a number of key concepts in Feuerstein's approach: cognitive modifiability and the importance of mediated learning, deficient cognitive functions and cognitive maps. We have already referred briefly to

cognitive modifiability; we shall now refer to the other concepts in turn.

The Instrumental Enrichment (IE) is directed not only at the behavioural level, but also at changes of a structural nature that will alter the course and direction of cognitive development: these structural changes are viewed as changes in the individual's characteristic ways of dealing with information.

Feuerstein distinguishes between learning that takes place between the child and the environment (using perhaps Piaget's intrinsic generative mechanisms) and learning that learning experiences mediated by an agent (using perhaps Vygotsky's extrinsic generative mechanisms). It is the richness or poverty of the second type of learning that Feuerstein would see as principally responsible for the adequacy or inadequacy of the learning environment of the child. These second, mediated learning experiences (MLE) are also held to influence the efficacy the first, unmediated experiences. Where the child has a poverty of mediated learning experiences, he could be seen to be "culturally deprived." Notice then, that there is no aspersion cast on the child's culture per se, but on the quality of mediation, which may be inadequate during a period of rapid social transition.

MLE's are themselves are of two types. We have already mentioned one - in which experiences are aimed at making the individual better able to learn from direct exposure from stimuli. The other type involves the transmission of information, values and attitudes. This dichotomy would be regarded as rather artificial in the accounts given in Chapter Two above - the values and beliefs of the mediator will determine what she mediates to the child. This theoretically weak concept may affect the appropriacy of a specific programme constructed in accordance with Feuersteinian principles: we need for example, the kind of fine-grained analysis such as that offered by Kok (cf 2.7 above) so that we can proceed from the culture specific aspects of the Zone of Proximal Development. (ZPD is not a term used by Feuerstein.)

Although the lack of MLE's can and does have detrimental effects on the child's cognitive development, these effects are held to be modifiable (and so they should be if cognition is modifiable). The IE programme represents an attempt to specify remedial procedures. From his clinical experience, Feuerstein identified what he called deficient functions,[1] which operate at three stages of the mental "act".

Impairments in cognition at the *input* phase include blurred and sweeping perception, unplanned, impulsive and unsystematic exploratory behaviour, and lack of or impaired temporal orientation.

Impairments in cognition at the *elaboration* phase include inadequacy in experiencing the existence of an actual problem and subsequently defin-

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[1] It is from the inverse of these deficient functions that Craig (1985) constructed her mediational operators.

ing it, the inability to select relevant cues on defining a problem, and impaired strategies for hypothesis testing.

Impairments in cognition at the *output* phase include egocentric communication modalities, trial-and-error responses, and the impaired need for precision and accuracy in communicating one's response.

The full list of deficient functions is not supplied here, nor is any full kind of appraisal offered. It is sufficient to say here that Feuerstein has a confused list that mixes attention, perception, and different kinds of cognition. We could for example make references from an information processing approach and show that he fails to distinguish between control processes and basic processes; from the point of view of Pascual-Leone's TCO, we find that he fails to make the distinction between subjective and silent operators.

However, Feuerstein's misnomer of a "cognitive map" would seem to be a useful clinical tool, which he uses to analyse, categorise and order mental acts. Seven parameters comprise the mental acts:

1. content: subject matter of a mental act;

2. operations: a set of actions by which information is elaborated on;

3. modality: language - figurative, pictorial, verbal - in terms of which a mental act is expressed;

4. phase: input, elaboration or output;

5. level of complexity: quantity and quality of units of information necessary to produce a given mental act;

6. level of abstraction: the "distance" between the mental acts and the objects to which it is applied, and

7. level of efficiency: the effort involved in a mental act related to the rapidity and precision with which it is produced.

In terms of our task analysis of schools, parameters 1,2,5 and 7 should deserve further attention. For example in a given task (eg Geography) one would want to know the content, the implicitly required cognitive operations, the M-power (Pascuale-Leone) required for the units of information, and the child's functional ability to carry out the task.

To look now at the specifics of the intervention programme: one of the most salient aspects of the programme is that it uses relatively "content-free" materials. It is assumed that to use "content-full" materials will lead to resistance on the part of the teacher and the learner. The idea is to keep the pupil's attention on the objective of correcting specific deficient functions rather than on the content itself. However, training in cognitive processes per se cannot make one immune to the need for the knowledge that is necessary to do effective problem solving in a particular area (for example, physics, chemistry, economics etc) (Arbitman-Smith, Hayward and Bransford, 1984).

Three of the subgoals of the programme have to do with affective-motivational factors: specifically, promoting extrinsic motivation to apply what is learned elsewhere, promoting task-intrinsic motivation, and also, very importantly, instilling in the learner a perception of himself as an active generator of knowledge and information, rather than a passive recipient and reproducer of the same. Feuerstein characterises the last subgoal as probably one of the most vital aspects of the programme. Perhaps it is also one of the most effective, since Arbitman-Smith et al (op cit) report that the programme seems to make a significant impact on the lives of the pupils, much more than would have been predicted by the relatively modest gains on IQ tests that have been reported, for example.

The IE programme is divided into fifteen "instruments", each of which consists of a set of paper-and-pencil exercises focussed on a particular deficient cognitive function. Fourteen of the instruments, which are used on classroom implementations of the programme, provide sufficient material for 3-5 one-hour lessons per week for two to three years. (The material may also be used individually.) The volume of this material would indicate the perception that considerable intervention is required before satisfactory gains are made.

This approach may seem to be rather reliant on a faithful use of materials. However, it is stressed that a critical aspect of the approach is the teacher's mediation of the materials. The teacher's attitude and approach to the whole enterprise would surely also have an effect on the affective variables that are so critical. However, while the teacher is the critical mediator, the tools themselves are also mediators of the more efficient use of cognitive operations. The point is also made that pupils are also learn about the functions, in other words, they acquire some metacognitive knowledge.

Part of the IE approach is that cumulative gains over time are expected. Having strengthened cognitive operations over what is a long and intensive programme, it is expected that the operations themselves will develop over the course of time. And indeed these expectations would seem to be borne-out: in a follow-up study with Israeli army subjects they found that the gains were maintained (Feuerstein, Miller, Hoffman, Rand, Mintzker, & Jensen, 1981). Feuerstein is adamant that a critical variable in the maintenance of these gains is in the content-free nature of the materials. He insists that to teach the operations on content will leave associations with that content, and there may be resistances to those materials.

In the IE programme, the most immediate changes are expected to be those of intellectual functions, that is, basic cognitive operations that have been exercised and extended. School achievement is regarded as a second order gain (especially since it is content-full), and mediated principally by changes in personality and motivation.

The IE Programme represent a remarkable initiative by any standards, and somewhere within it, it would seem to contain the seeds of Israeli initiative that brought success in other fields, for example in computer-assisted arithmetic (the TOAM program). However, before South Africans import Israeli successes, they should examine the particular details of implementation, teacher effectiveness and the educational milieu: we could otherwise land ourselves with costly poor imitations (Macdonald, 1987).

It would be extremely costly to decide to implement IE per se in South Africa, because of the commitment of both time and effort. If it were possible, the relative effect of content-free and content-full programmes should be weighed up, since up to one quarter of curriculum time could be devoted to such an enterprise. Furthermore, to give to one sector of our pupils a programme that is so obviously compensatory could be construed as labelling them and doing very costly first aid. What is construed as a single-minded attempt at social equity for a minority in one situation could be misconstrued in South Africa, where there is no common mind.

The one particular focus that is unique to the IE programme is the concern with transforming the learner's image of himself. Although this aspect has not been formally researched, and although no theory of cognitive development (e.g. Piaget and Pascual-Leone) can give any adequate account of it, it is acknowledged as a central factor. The area of affect, self-image and motivation could well benefit from further, insighful research.

To summarise the contribution of IE in terms of our model.

1. It does not help us to understand the nature of formal learning in a coherent way.

2. However, basic cognitive operations, which are assumed to be universally acquired, are "activated" in a conducive socio-cognitive milieu.

3. The programme relies explicitly on expert mediation both by teachers and materials; we could not assume the former in our context.

4. A very favourable aspect lies in changing the self-image of the learner to one as an active generator of knowledge and information: this is nothing less than a micro-political change.

5. This programme is theoretically in line with the Natal paradigm in that the focus is on the learning task of the child: issues of "culture" do not enter the programme because a unified political vision for the country obviates the need for such a discussion.

3.1.3 Teaching process skills

The teaching of process skills, for example, classifying, inferring, etc was until fairly recently the preserve of the the science teaching pro-

fession. For example, the Science ... A Process Approach (SAPA) was developed during the 1960's by the Commission on Science Education. Other examples of work in science include work by Galton and his associates at the University of Leicester at the junior secondary level, and work at the primary level by Wyn Harlen from the University of Sheffield and her associates. For further details of this work, reference may be made to one of the other final project reports: Standard Three General Science Research.

The focus of this short section is on a broader orientation towards teaching process skills *across the curriculum*. Collins (1985) has worked out an approach to the systematic questioning of pupils, based on the analysis of "expert teaching strategies". (These would inform circles 3 and 4 of our diagrammatic model in Chapter Two.) This approach would include the following strategies on the part of the teacher:

1. asking students to form hypotheses

2. asking students to test hypotheses

3. encouraging students to formulate alternative hypotheses

4. asking students to make predictions

5. asking students to consider alternative predictions

6. entrapping students to reveal their misconceptions

7. tracing consequences to a contradiction

8. encouraging the pupils to question authority (sic).

It is clear that this approach will require a teacher to be able to guide a high level of interactive discourse on the spur of the moment; a less dynamic approach might be to build aspects of the strategies into relatively structured materials. Let us look at some of the purported advantages of the "inquiry method" that Collins (ibid) adduces:

1. Modelling of scientific thinking: in time the pupils should internalise the strategies - heuristics - that the teacher uses. We should like to comment firstly that the brief set of strategies described is not necessarily an accurate modelling of the process of scientific thinking, which is riddled with false starts, blind alleys etc. These aspects should also be built in if possible. Secondly, the modelling of scientific thinking could be a candidate for working in the Zone of Proximal Development, but then, the strategies should be carefully matched with what the teacher can succesfully mediate. The components of successful modelling would have to be empirically determined in order to determine its status as an "ideal" mediational operator.

2. The approach will generate involvement and motivation on the part of the pupils, getting participation in the formulation and evaluation of theories. We should like to comment firstly, that this aspect would parallel Craig's (1985) mediational operator of generating task readiness. Secondly, from the general tone of Collin's description, it is clear that the teacher is the pivotal element in the whole process but our research in Standard 3 science teaching indicates that it is very important to the teachers themselves that everybody (that is, both teacher and pupil) has a clear understanding of who exactly is in control of the whole teaching/learning process.

3. The approach should allow for individualisation, insofar as the teacher can deal with the pupils' ideas individually, and can shape their own responses to fit into the student's alternative conceptions. Our comment would be firstly, that the pupils may well not be typically forthcoming with their own ideas, since as we have seen from Craig's and Kok's work, the children would have been learning for a long time that their ideas are to be made constantly subservient to those of the teachers. Secondly, the teacher would have to have a very good grip on the structure of the subject matter itself in order to make constructive the dialogue between her own conceptions and the pupils' so-called "alternative" conceptions.

4. The approach should lead to a deep understanding on the part of the pupils, since the teacher probes the students with difficult cases and entrapments. Although this is clearly a benefit in theory (see also the section 3.4.2. below), in practice it would require a great deal of the teacher to keep constructing what Collins calls "positive and negative paradigm cases" and "near hits and near misses".

5. The last advantage which Collins posits is that the approach should lead to genuine predictive thinking. Pupils will not only learn rules and theories, but they will also learn how to make predictions about novel situations. If indeed the approach could be fully implemented, then this undoubtedly would be a positive outcome.

Collins himself sets out five disadvantages of the inquiry method which he can discern. We give these below, adding our own comment where appropriate.

a. This is a low information transfer route: lectures or reading are much faster to this end. Collins notes that the use of this method is usually combined with extensive reading, followed by inquiry dialogues based on the reading. In our situation, time is usually saved by rote reception learning, and a method that required extensive reading would not currently be viable because of the acute shortage of reading materials, as well as the difficulties that pupils have with extended independent reading.

b. There may be an appearance of negative reinforcement for the pupils, since the method can give the impression of exposing ignorance and misconceptions. Given the co-operative nature of the

learning situation as indigenously conceived, we would see a basic assumption of pupil incapacity being central, but that it is important not to make this explicit in a way that would humiliate the pupil. Furthermore, the teachers' view of error we discovered, was not that it was a means to a process of thinking, but rather that it is an undesirable end in itself.

c. There is the possible difficulty of uncertain participation, insofar as the teacher interacts with whoever offers ideas and dialogues, and he would have to be careful that everybody is participating. This means that the teacher would have to continuously draw reluctant pupils into the discussion. The problem of participation may be exacerbated by the concept of negative reinforcement that we outlined above.

d. The key disadvantage of this approach is the reliance on the sophistication of the teacher, who must be able to think quickly, and avoid the pitfalls described at (b) and (c) above. However, once the teacher is familiar with the parameters of the method, her preparation time would actually be lessened; she would merely be required to choose "cases" and problems wisely. Collins points out that in American education, teachers shy away from the method because they are unfamiliar with it, and because they haven't had sufficient practice with it.

e. One of the other key disadvantages of this method, as Collins readily admits, is that the purported advantages are really part of a stereotype of the inquiry method as the best method. When tested on conventional school tests, pupils are not necessarily likely to score higher, but this may in part be due to the fact that they may have fewer "facts" at their disposal. However, the goal of the method is that it should have deep predictive understanding (meaningful inquiry learning in Ausubel's (1985) terms), and Collins points out that until now it has been difficult to design (school) tests that measure these higher level goals. Perhaps long term gains of a general nature would show up on sensitive tests.

When we have considered Bereiter and Scardamalia's work below, we will find that much of what Collins has suggested could be meaningfully integrated into an information processing approach, and when we try to integrate our findings at the end of this chapter, given the parameters of the current situations, we will find something of real benefit in this approach. In general, the facilitation of the process skills can well be kept in the hands of the teacher (with the aid of materials); it is the level and extent of the process skills to be induced that would have to be negotiated. At the junior primary level, simple process skills such as observation, comparison/contrast, making simple predictions, etc may well be built into learning across the curriculum.

3.2 HEURISTICS-ORIENTED APPROACHES

3.2.1 The nature of heuristics

The word *heuristics* comes from the Greek *heuriskin* meaning, "serving to discover". Polya (1957) in a classical study on problem solving used the word to connote inductive and analogical reasoning leading to plausible conclusions, rather than deductive development of rigorous proofs.

More recently the term has been used in research on machine intelligence to sharpen a distinction between two types of procedures that can be realised by computer programmes. The first type of procedure, called an algorithm, is a step-by-step prescription for accomplishing a particular goal. By definition an algorithm accomplishes what it is intended to accomplish.

In contrast, a heuristic is only a good bet, a procedure believed to have a reasonable likelihood of yielding a solution, or at least bringing one closer to a solution. But it is not guaranteed to work. Heuristic procedures are used when algorithms are not known or would consume too many resources. The more generally applicable a heuristic is, the more powerful it is considered to be. If computer scientists succeed in developing heuristic procedures effective across a wide variety of problem types, then this will demonstrate that the idea of effective general strategies is valid.

Two treatment of heuristics have been particularly influential: that of Polya (ibid) and Newell and Simon (1972). The application is so interesting that we have taken the liberty of coalescing aspects of the two approaches in order for the reader to have a clearer picture of what heuristics-oriented approaches look like, how they bear some similarity to the categories suggested by Sternberg, and also to other rapidly proliferating work on metacognition.

There are four stages in Polya's Model, and the Newell-Simon approach has been introduced under those categories.

1. Understand the problem

> * Make sure you understand the unknown, the data (i.e. the givens) and the conditions that relate to the data: in computer science terminology this heuristic would translate thus -
>
> * Make sure you understand the nature of the goal state, the initial state and the permissible operations.
>
> * Draw a graph or diagram and introduce suitable notation. The purpose of this heuristic is to concretise the problem, and part of this has to do with visual thinking (cf. also 3.4.2 below)

* If one way of representing a problem does not lead to the solution, try to restate or reformulate the problem. This is very important, because if one does not have a clear representation, a solution may be precluded.

* Draw inferences about the initial and goal states and add them to your representation: sometimes what is inferred about initial and goal states can fundamentally alter the character of a problem so that it becomes easy to solve.

2. Devise a plan: this involves formulating a general strategy, not a detailed proof. Formulating such a strategy is an inductive process, not a deductive one. Most of Polya's heuristics here involve bringing to bear related problems that one already knows how to solve.

* Think of a known problem that is structurally analogous to the present one and try to solve that. (Some psychologists have considered the ability to see similarities and to engage in analogical reasoning to be among the most reliable indicators of general intelligence.) However, surface features may obscure deeper relationships that may have greater significance (cf. Craig's mediational operator on this: 2.7.)

*Think of a problem that has the same kind of unknown but is simpler.

*If you cannot solve the problem on which you are working, see if you can transform it into a problem whose solution you know.

*Simplify the problem by looking at special cases, for example, where there are specific values that may help to concretise the problem.

*Make the problem more general, and see if you can solve that: the solution to the more general case should be applicable to the more specific one.

*Break the problem into parts. If the parts are not manageable, break these into smaller parts, continuing in this fashion until you arrive at problems of manageable size. (One could use method and result of these interim parts to solve the more difficult problem).

*Organise the paths that are equivalent with respect to the final solution; then systematically try one sequence from each class.

*Define an evaluation function over all states including a goal state; then, at any state, choose an operation to achieve a next state with an evaluation closer to that of the goal state. We could paraphrase this heuristic by saying that at any choice one should select that intermediate goal that seems most similar

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to the goal state. (We shall see in 3.4.2 below that this operation is an extremely difficult one for children to apply.)

*Work backwards from the goal to the initial state: this heuristic is valuable when there are many operators that could be applied to the initial state. Working backwards can help to reduce this initial plethora of choices.

*Assume that the goal state is false, and show that this leads to a contradiction. One may need to make a detour and this could constitute a major source of difficulty. (This is called the method of indirect proof in mathematics.)

3. Carry out the plan. This is the detailed proof, and here is where deductive reasoning comes in.

In mathematics, this part is deductive, so there are no true heuristics, except perhaps "check each step".

4. Look back, i.e. check your results.

*Try to check the problem a different way.

*Check the implications of your solution.

If one can find a second way to solve a problem, and it yields the same solution, then this will increase our confidence in our solution. Also, if one checks the implications of the first solution, and they are true, this will also increase our confidence.

The immediate relevance of much of what has been presented above might be rather opaque: however, the challenge for the cognitive developmentalist is to to determine which of these heuristics children would be capable of using, and under which contexts they would be most likely to use them.

Probably if training in heuristics is to be effective, then the focus should not only be on heuristics, but their implementation in a variety of contexts. These two approaches - Polya's and Newell and Simon's - provide applied examples: this is useful to problem solvers (but not to us because in many cases they are too high level), and obviously to those who would try to teach from such an approach. Perhaps these two approaches could be used in teacher training.

Heuristics would seem prime candidates for courses on thinking skills. They have a great range of applicability and hence should often be beneficial. They are relatively well-specified and hence programmable, and there is some consensus that these heuristics are what expert problem-solvers really do use. Also there appear to be sufficiently few, so that from this point of view it would be feasible to teach them.

The difficulties with heuristics are seen by Nickerson et al (ibid) to be two-fold: firstly, there is the managerial problem of knowing when to apply a particular heuristic, eg in what contexts should one try break-

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ing a problem into sub-problems. Secondly, the heuristic may not be concrete enough to be implementable in an unfamiliar domain.

However, they believe that these two difficulties can be overcome by specific techniques; also, that problem-solving heuristics should rank high on any aspects of thinking that can be taught.

We are now going to look at a particular example of a programme that teaching heuristic thinking, that is lateral thinking of De Bono.

3.2.2 Lateral thinking and the CoRT programme (the Cognitive Research Trust)

We have chosen this example, since CoRT principles have been built into a new set of experimental materials designed for Standard 3, by the Institute for Language Teaching at the University of Stellenbosch.

De Bono (1968, 1970) is most famous for his distinction between *vertical* and *lateral* thinking.

Vertical thinking is roughly equatable with logical thinking - sequential, predictable, conventional thinking within a frame of reference. Vertical thinking has the necessity to be right at every stage, as well as the necessity of having everything rigidly defined.

Lateral thinking, on the other hand, is not necessarily sequential, it is unpredictable, it is not constrained by convention, and restructures the "problem space".

De Bono holds strongly that premature formalisation and expression of an idea may inhibit its natural development: in order to obviate this he suggests a complementary role for lateral and vertical thinking. Lateral thinking generates the ideas: vertical thinking develops them.

For de Bono, the major purpose of vertical thinking should be to demonstrate the soundness of the conclusion rather than finding the conclusion per se. This line of argument would parallel the line of thinking of Polya (ibid) who shows that there might in fact, in genuine problem solving be a circuitous route to find a solution; one can demonstrate the validity of the conclusion later.

The CoRT Programme (1973) has six units:

1. Breadth (this unit should be taught first). It emphasises thinking about a situation in many different ways that a person might ordinarily neglect, eg consider all the factors, short and long-term consequences, and objectives.

2. Organisation: this unit help student direct attention effectively and systematically to a situation, without a loss of focus.

3. Interaction: this unit is concerned with matters of adequate evidence and argument.

4. Creativity: here the focus is on strategies for generating ideas; also on editing and evaluation of ideas.

5. Information and feeling: here affective factors are considered, together with other factors that were covered earlier.

6. Action: here a general framework is provided for attacking problems.

CoRT teaches an option in thinking 'Po' - which means, reserve judgement. It has been found that people are more likely to use this option, if offered. Perhaps this is because it is a useful shorthand expression, which more quickly allows us to reserve judgement than if we would have to say to ourselves: "I don't know - I'd better think about it".

The programme rests on "operations", not in the strong sense, but rather these are questions one asks oneself. De Bono provides mnemonics, for example, CAF (consider all factors), PNI (positive, negative, and interesting points). The CoRT operations are purportedly easy to apply, and a major aim of the programme is to make a range of such operations part of the learner's active behavioural repertoire, or way of being. Students are supposed to become more flexible, they are likely to see more sides to an issue, and more alternatives to a problem.

Lessons are taught in isolation from other subject matter; de Bono feels that one should not fuse them with other subject matter, especially for younger students, as this would "dilute" the clarity of their principles. Thinking is regarded as a skill, that can be enhanced by attention to the various operations in the programme. Obviously the question of the transferability of the skills to other situations would be one of central interest.

CoRT has been adapted and expanded in Venezuela by de Sauchey of the Ministry of Education. Each lesson expanded to 4 lessons, with a gradation from relatively concrete to more abstract problems. Evaluative research (1983) by de Sanchez and Astorga showed that after implementation, significant effects emerged over a period of 2 - 3 years, insofar as there was a transfer to similar tasks, with children from 10 to 12 years. It is important to take note of the fact that gains take time to consolidate if there is a viable implementation programme, ie in this case 2 periods per week.

A general evaluation that we can offer after such a quick survey is that CoRT is not adapted to special needs of complex performances, such as for example, expository writing. Rather, it seems to be more episodic in nature. Looking at the parameters of classical heuristics described earlier, and the brief outline of the six units given above, it seems that CoRT is not purely heuristics-oriented; what is included are components addressing learning and motivation, as well as self-monitoring and

self-evaluation (aspects of meta-cognition). Classical heuristics would not be suitable for teaching children from middle to late childhood.

To use CoRT in the black primary education would perhaps require implementation in two ways. Firstly, CoRT would be a general overt symbol of change and development, whereas in fact detailed attention would have to be paid to the extrinsic generative mechanisms of change i.e. in the nature of teacher intervention. We look forward with interest to the results of the current Upttrail Trust (Suggestopaedics) Project (University of Stellenbosch) which is teaching CoRT to Standard 3 teachers and getting them to apply this to their pupils' lessons.

To conclude this section, we should look at heuristics approaches in general. In the same was as "cognitive operations" reflects specific conceptions of intelligence, the "heuristics" approach reflects a conception of intelligence as problem-solving, creativity and meta-cognition.

The aim is to break tasks into steps that the learner can perform readily. The instructor attempts to teach the learner what steps to take and when to take them.

This approach promise effective instruction on two conditions:

1. There should be sound strategies reflecting an insightful analysis of the performances to be taught.

2. Instruction should pay heed to the problems of thorough learning and transfer.

These conditions are relatively difficult to meet, so the development of a truly powerful heuristics approach may be a gradual process. An expanded approach would depend on the analysis of the task in question into manageable subtasks.

The second difficulty with the application of the heuristics learning is that heuristics advice may be difficult to apply in a particular context, especially an unfamiliar one. Also, the problem solver may forget to apply the heuristic. So, even if person can recite a strategy, he may not be able to apply it in various situations.

The heuristic is a higher order thinking skill that is under conscious control wherein lies part of its difficulty in application; in contrast, the learner could potentially automate cognitive operations such as those described in Instrumental Enrichment.

To compare cognitive operations and heuristics:

* heuristics approaches are more "useful" insofar as they have application for manifestly complex tasks.

* cognitive operation approaches train the subset of cognitive operations thought to be relevant to task, and practice on the task itself.

However, these claims should be checked out with

* a "task analysis" of the typical problem situations presented,

* what the current curriculum requires, and

* what children by Standard 3 should be able to do.

It may be that typical school tasks would still be relatively simple, in terms of their problem solving requirements, but highly loaded on content. If this is indeed the case, then what we have argued in 3.1 and 3.2 would indicate that perhaps it is the curriculum that should be critically addressed: in other words the content to be covered should be subjugated to the thinking skills that should be facilitated.

To summarise this section in terms of the model we have been trying to develop:

1. CoRT does not in and of itself help us to understand the nature of school learning, although De Bono, in a general way, has tried to extend our notion of thinking. However, the challenge that would remain is to reintegrate the products of lateral and vertical thinking in producing the more orthodox types of learning required in school.

2. The nature of the mediation is not spelt out in a way that relates to orthodox teaching, although it is apparently easy to get teachers to use the numeric based strategies.

3. The implicit role of the learner to become part of a more active process of learning that is less authoritarian than that to which he would be accustomed to; the tyranny of "the right" is lessened.

4. The most salient shortcoming in CoRT is the lack of adequate grounding in orthodox thinking skills theory. Allied to this is the remoteness of the activities from skills such as reading and writing. However, the hidden curriculum of making learning less formal and engaging the teacher and pupil in new modes of negotiation would make the approach worthy of further attention.

3.3 FORMAL THINKING APPROACHES

These approaches have primarily been developed at university freshmen levels, to help students to better prepare for the understanding that is expected of them. The lack of preparedness is most commonly conceived of as the failure to reach the stage of formal operations, as conceptualised by Piaget. There is a paradoxical relationship here.

1. Piaget's notion that abstract thinking depends on a small unitary set of structures has increasingly been under attack. Piaget (1972) conceded that we might only attain formal operations in personally important and familiar domains. However, we can go further and say that intellectual development has a much more piecemeal character than supposed by Piaget -- is it useful to see the end of the cognitive development as the stage of formal operations? Cross-culturally the concept of formal operations may not be particularly productive, although it is important for aspects of secondary school learning (cf. 2.3 above).

2. Although we might not be looking at a "stage" with its full theoretical ramifications Piaget has analysed valuable aspects of scientific thinking, for example in making salient the notions of

   - proportionality
   - the control of variables
   - the hypothetico - deductive method.

Also, a valuable notion is that one should build pedagogy on a bridge from concrete experience to abstract thinking. So, the programmes built round these concepts can be meritorious independent on status of Piaget's theory, and lead to the development of good strategies.

The DOORS (Development of Operational Reasoning Skills Project) based at Illinois Central College (described by Nickerson et al) is an interesting example of a college programme that has in it aspects of formal operations skills, as well as process skills.

Reasoning skills were identified as follows:

English: History: Sociology	Mathematics: Economics: Physics
Observation (Identify variable)	Observation (Identify variable)
Description (of variable)	Description (of variable)
Comparing or relating (comparison and contrast)	Comparing or relating (Graphing)
	Inferring (Graphing)
Classification	Classification
Summary	Hypothesis statement
Cause and effect	Separation and control of variables

Figure 3.1 Reasoning skills at the tertiary level

This programme shows an awareness of the need for operational reasoning skills in the Arts and Social Sciences, not something that we should leave solely to the "hard" sciences. The question arises as to how we could use these insights in our situation: obviously some analysis can be done at the level of curriculum design.

The COMPAS programme, which was a direct outgrowth of the DOORS project discovered that when lecturers tried to apply what had been taught in specific principles, they found that they had to sacrifice some content. The question arises here too: can we offset the cost of omitted content by increased capacity for more integrative, autonomous learning? To do this would need a major change of orientation on the part of departments of education, one which no centralised one would easily make. However, as Nickerson et al observe, the major impetus for these programmes came from the educational establishment - lecturers with years of experience in teaching basic courses in standard ways. This fact speaks clearly to the need for new approaches as perceived within the teaching profession. Lecturers have thought hard about their teaching goals, and the Piagetian framework has given them a language for exploring alternatives with colleagues from different disciplines. In a sense they could be said to have performed part of a task analysis for learning at the tertiary level.

We will spend no more time on these formal thinking programmes insofar as they are slightly remote from our immediate concerns. What we have learned here is that the productive aspects of Piagetian theory can be helpful in pedagogy, and that the momentum for change can come from within the teaching profession.

3.4 THINKING THROUGH LANGUAGE

3.4.1 General characteristics

These programmes tend to pay heed to the construction of complex products eg. essays, stories, arguments and the like. They mirror reality in some degree in this, as real world situations demand a range of intellectual activities that far exceed the typical textbook problems. Real world activities typically have many parts and aspects and require an extended process of construction and revision (for example, developing a mathematical proof, writing an essay, or running a business operation). It seems to us that this is a valid extension of a conventionally constrained curriculum.

In Section 3.3 above we saw the generally accepted importance of representations to problem solving. One can aid the systematicness and objectivity of thought by using devices like diagrams, lists and narrative descriptions. In real life situations these representations can become quite complex. According to the Vygotskian paradigm we may internalise representations (but not in an isomorphic form), so developing systematic overt representations may finally be a significant aid to thinking.

3.4.1.1 Writing as an occasion for thinking

The contribution of writing to our culture is primarily that it keeps a permanent record for us, allowing us to make productive use of previously generated knowledge. However, writing is not merely a way of transmitting knowledge or thinking, it is a means of thinking itself. So writing is relevant to thinking because firstly, it demands thinking and secondly, because writing is a vehicle for thinking.

Writing would seem to be more closely characteristic of thinking than other formidable intellectual activities such as playing chess or bridge, or designing electronic circuits. We do not usually treat skill in these activities as a definite indication of general thinking ability, but if a person writes well in a substantive sense, we would attribute the ability to think effectively in a fairly general sense (Kitzhaber, 1968).

If we follow this line of reasoning, we can come to the possible conclusion that we can learn about thinking from studying approaches to writing. Conversely, instruction in writing might be a good context in which to exercise and develop thinking skills.

Writing is a complex skill: the most basic level involves the physical formation of letters on the page. The knowledge of the spelling system is also implicated; even when these two skills are automated (and the latter can easily be accessed when necessary) the processes of word, phrase, sentence, and discourse construction all need to operate. Furthermore the planning, word-generating and organising activities are intrinsically interactive.

Bereiter (1980), commenting on the stages in writing skill, sees the essential difficulty as one of managing multiple constraints. The young writers first effort falls naturally into a minimally demanding pattern; Bereiter calls this "associative writing". The writer puts on paper whatever comes to mind, reaches for another thought, and so on. Further stages in the development of writing are as follows: "performative writing", similar to associative writing, but with good control of grammar, spelling, and other aspects of mechanics', "communicative writing" - writing shaped to the audience, taking account, "unified writing" - writing in which the writer uses himself as a critical reader or model of the audience; and finally, "epistemic writing" - writing that functions as a development of knowledge. For the purposes of the Threshold Project problem domain, one would be interested in fleshing out the different aspects of "performative writing".

Interesting sources and research on writing instruction have been developed by Scardamalia, Bereiter and associates. The Little Red Writing Book (Scardemalia, Bereiter & Fillian 1979) offers a collection of exercises for teachers to adapt. In these, the authors develop the potential for peers to critique each others' work, with the motivation of a game-like format. They suggest the desirability of other sources of feedback apart from the teacher.

Anderson, Bereiter and Smart (1980) report on a procedure for activating so-called inert knowledge in writing: this involves asking pupils to list all the words they might use in a topic before they write about it. This procedure works much more productively than planning from main ideas.   Scardamalia and Bereiter (1981, 1985) have also worked on "procedural facilitation" where the students are helped by specific external prompts on card. (This development is part of a deeper enterprise which is taken up in the section below). As one Grade 4 child said:

"They had all the things down on paper and you just look at it and you can think. The other way you have to get it out of your head".

The authors say that many children express this Vygotskian sentiment, seemingly aware of the effects of limited working memory capacity.

Nickerson et al (ibid) observe that the problems that make writing difficult are not unique to writing, for example, problems of cognitive load, taking into account others' needs and perspectives, using oneself as a model of one's audience. Hence instructional strategies such as teaching schemata, organising instruction from the "middle out", and operationalising more subtle standards into public achievement tests are good tactics in improving the performance of other significant intellectual tasks.

With regard to the stronger notion of writing as a means of thinking, Nickerson et al (ibid) stress that it should not be assumed that conventional forms of written expression are necessarily the only forms of thinking by writing. They perceive of other forms, such as instruction on "thinking on paper" as emphasising the heuristics of using writing (as well as diagramming, listing, note taking, etc) for oneself as a means of thinking through a problem or issue.

3.4.1.2 Knowledge telling in writing: a paradigm case of the nature of school generated knowledge

The phenomeon of inert knowledge was identified originally by Whitehead (1929). This is propositional knowledge that the student can express but not use. If we construct a model of knowlege in memory, in information processing terms, we think of it as being situated in a three-dimensional space, with both horizontal and vertical connections. Learning is supposed to add both new elements and new connections, and it is in the richness and structure of these connections that the difference between inert and usable knowledge would seem to lie. We are talking, I think, about the richness of semantic networks.

An effect of the general modes of education would be that it specifically avoids the forming of connections between previously separated

knowledge sites.[2] In other words there is not an active integration of new information with what has been learned before. (The description by Ausubel, 1985, of rote reception learning is apposite here).

A model of the *"knowledge-telling strategy"* as applied in expository writing is developed by Bereiter and Scardamalia (1985). This model can be found at Figure 3.2 overleaf. (It describes the process that could generate attributes typical of examination answer and student essays). Two things are needed to be extracted from the topic or question; the first is a set of descriptors drawn from key lexical items, and the other is information to guide the choice of a schema for the text to be produced (for example, story grammar schemata of such discourse forms as explanation, thesis and defense etc.) Discourse generation is set in motion when short term memory is examined for an item that matches the selected schema requirement and the descriptor; the items are translated into text, and the process is repeated until the text is judged finished.

This strategy is adequate for school tasks such as writing an essay "What I did in my holiday". The model will work well if the topic evolves strong associations, or prewriting activities have primed relevant stores of long term memory. However, crucially, the strategy lacks any provision for *goals* (apart from technical criteria). The lack of procedures for testing content, means that this strategy is inadequate for tasks that require backward as well as forward processing and those which require strategically directed assessing of different knowledge stores. (Notice that tasks such as apparently very simple everyday tasks like deciding where to go on holiday occupy knowledge-unrestricted problem environments, requiring flexible access to long-term memory stores.)

Most school tasks do not pose the kinds of knowledge access demands the tasks of everyday life do. Instead, knowledge demands are usually restricted to retrieving hierarchically- or episodically-stored information. There is usually a high degree of congruence between the way the information was presented for encoding and the demands for recoding. (In other words, "test as you teach" is a widespread practice.) It is for us to decide whether the schism between life tasks and school tasks is productive in the current curriculum.

However, expository writing can well qualify as a school task that more closely approximates the demands of a real-life task, particularly when children are asked to do a 'project'. This type of writing demands problem-solving as well as memory search, and so would typically require the elaboration of constraints and the setting of goals and subgoals,

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[2]   An intriguing extension of this thinking is that not all memory contents are internally connectable, so that the mind may have to form relations among memory contents by observing their manifestations in the integrated external behaviour of the organism (cf Luria, 1973). The idea is entirely consonant with the Vygotskian notion of using outer symbol systems as instruments.
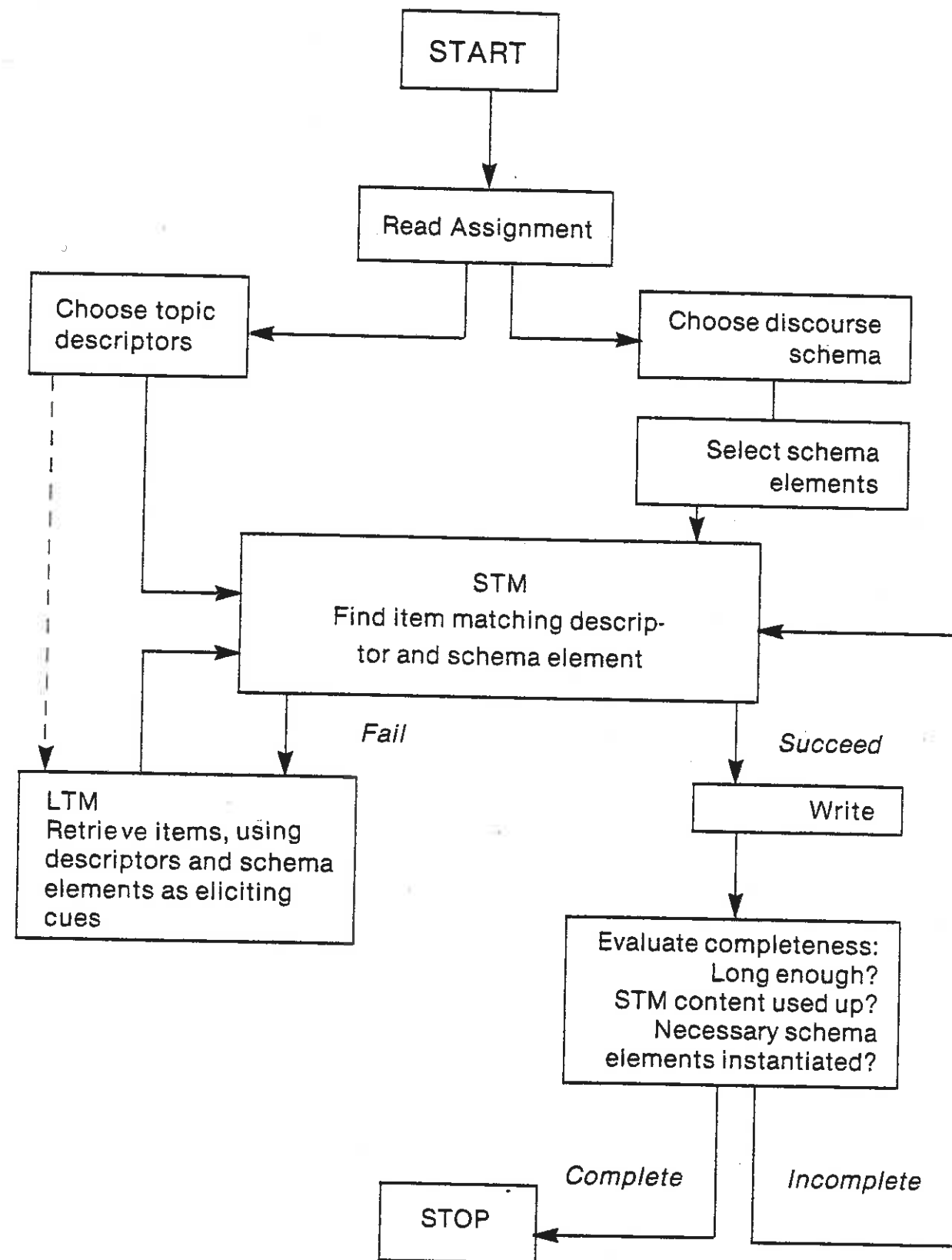
Figure 3.2   *Knowledge telling strategy (Bereiter & Scardamalia, 1985).*

and the re-evaluation of these. The wide application of the knowledge telling strategy given above, is compelling evidence that pupils generally have difficulty with expository writing, treating it more like a more narrowly-defined school task.

There also appear to be cognitive-developmental constraints here, as in-depth research by these researchers has shown. First, there is the absence of goal-related planning; secondly, production can be influenced by controlling the choice of schema elements; third, there is the lack of internal constraint in the writing, and the lack of inter-connectedness is consistent with a forward-acting, serial-generative process. Finally, there is the remarkable disinclination of children to make other than cosmetic revisions to text. (In fact, revisions would presuppose some kind of goal-directedness, denoting problem solving rather than knowledge searching.)

Bereiter and Scardamelia suggest that the cognitive strategies of the pupils has caused the instructional system to adapt to them. In the end, what is taught, is what the knowledge-telling strategy is equipped to handle, ie inert knowledge. Children use knowlege telling as a way to do work that, without such a strategy, would be beyond them. Knowledge telling is not a conscious strategy and hence pupils have no reason or means to evaluate it themselves; the responsibility is seen to lie with the educators.

In the South African situation, it is a pleasant surprise not to find that we are in a unique situation. What can be most narrowly conceived of as a cultural predisposition to rote reception learning, can also be cast in a broader conception of our immature strategy for dealing with a large learning challenge. The absence of active integration of new information may also be a continuous, inherited problem, insofar as students need to have a teacher who can either direct or model the process of active integration. There are no algorithms for learning to write compositions, because the choices of action are complexly contingent on the knowledge context. (So even if we could abstract an algorithm for writing about dogs, there is no assurance it would work for (writing about) cats!). An automatic recourse in the information processing approach would be to the level of strategy description, or heuristics. However, the use of these in writing presupposes a high level of metacognition, so that one is able to assess and consciously manipulate one's strategies.

Scardamelia and Bereiter (1985b) suggest that it is not possible to build a complex effective strategy "from the ground up" with verbal strategy descriptions. Such rules (principles) are not considered useful for teaching pupils who use immature strategies for complex knowledge-processing tasks[3] rather, Scardamelia & Bereiter regard "self-

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3 It is important to note that while Bereiter and Scardamalia isolated knowledge-telling as a cognitive-developmental phenomenon, they do not reserve their instructional solutions for use with young learners; rather they refer to "immature strategies".

regulatory mechanisms" (Brown & Campione's (1981) term) as more promising processes.

As examples of self-regulatory mechanisms, Brown and Campione list checking, planning, monitoring, revising and evaluating. This list is not exhaustive, but they are good illustrations of information processing skills or executive functions that are separately amenable to improvement. (Each of these functions involves its own goal setting, knowledge retrieval, processing and storage operations). Enhancing these mechanisms can be seen not only as a way of contributing to immediate performance, but also to further *development* of the cognitive system. This development is conceived of as the rules by which the system operates indirectly changing by means of change-inducing agents. In other words, one doesn't teach new rules of task performance but the children acquire them.[4]

Let it be said immediately, that Scardamalia and Bereiter do not evaluate whether they have actually induced this development. This will be a problem for further research.

The two methods proposed are *procedural facilitation* and *goal concretisation*. To take each of these methods in turn: in procedural facilitation, there is the assumption that the executive procedure for undertaking the tasks and bringing it through to some kind of completion, exists. Another executive function, ie of planning or evaluation is added to this, in such a way as not to increase the information processing load in the executive system.[5]

This is done on the assumption that children are able to use such an executive function in other situations, and even to perceive their usefulness, but are unable to place them in their existing executive procedures.

Scardamalia and Bereiter designed a CDO - compare, diagnose, operate - process for use in composition. At the beginning the children use the cycle after each sentence and only once then. Comparison and diagnosis is reduced to a limited set of alternative evaluations (eg "People may not understand this point"); similarly, there is a limited set of revision tactics. In their experiment (Scardamalia and Bereiter 1983) the set of evaluations was restricted to concerns such as interest, clarity

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4 One can best promote genuine learning in a task domain where the rule systems are too complex to teach by promoting self regulatory functions that support rule acquisition by activity. This process can be translated into terms for learning language per se (cf. Krashen 1981)

5 The information processing load would normally be increased by the selective attention and recall required to interrupt the task procedure; the new mechanism requires processing capacity (partly because of its newness) and may erase out short term stores required elsewhere on the task.

and plausibility, specifically to direct attention away from mechanical problems.

An important aspect of *procedural* facilitation resides in the fact that the cards mediate the possibilities that the children have to check for; usually the teacher fills in as *substantial* facilitator, leaving the child merely to generate an alternative to the already evaluated piece of text. It may be that this method would more readily bring children to themselves being the determinants of change in their own writing skills, especially if they are finally able to internalise the evaluative function. However, the brief research in question only indicated that children from grades 4, 6 and 8 were happily and easily able to integrate this external self-regulatory function into their writing activity.

The second method, concretising of goals, is less immediately novel, although it is theoretically well-founded. As was said earlier, children tend to regard expository writing as a task of telling what they know rather than a task of reaching some compositional goal. The procedural facilitation described above cannot alter this tendency, neither do explicit imperatives help children to pursue such goals. Compositional tasks in real life tend to have abstract, unstable goals (for example, finding a house with certain liveability requirements), and children are helped when these goals can be concretised (that is, as concrete, stable goals). Children have to be helped on the "high" road that requires that one keeps reassessing partial solutions and goal constraints in the light of each other and the global goal.

The research group of Scardamalia & Bereiter has done research on designing ending sentences and monitoring children's composing strategies as they try to produce a composition that will lead up to these. The children engage in more goal-directed processing when given an end to work toward, than when they do in working forward from a topic or initial statement (Tetroe, Bereiter and Scardamalia, 1981). These researchers have also designed instructional tasks that concretise other global goals, for example, converting the abstract and intangible goal of "realism" by the concrete goal of constructing a fictitious narrative that will pass for a true account.

Bereiter and Scardamalia are currently addressing the difficulty that pupils have in *constructing* goals in compositional tasks. They see the construction of goals as an integral part of what they call *intentional cognition,* which they contrast with what they describe as merely responding to impinging problems and contextually defined goals. In trying to develop the skill of goal construction, they use procedural facilitation of the planning process itself (rather than procedural facilitation of operations on the text, as we described earlier).

3.4.2 Commentary on the "thinking through language" approach described

In order to streamline the structure of this rather complex report, it has been necessary to rationalise the categories for description. Although the present approach has been described as an attempt to teach thinking through language, it will be clear that the Bereiter - Scardamalia project is unique in its application of sophisticated information processing concepts to what is essentially a language art, ie expository writing. By analysing this process as an instance of a complex cognitive process, they have "opened up" the analysis of this skill in such a way that we can see which are the developmental aspects. By "developmental" these researchers appear to be neutral with regard to either instructional/institutional or individual development factors. The particular advantage in their procedure for inducing self-regulation mechanism development is that it could be used by teachers who themselves may not have easily accessible heuristic knowledge, but who could benefit simultaneously with their pupils in developing autonomous self-regulating mechanisms.

Another specific advantage of this approach is that it directly addresses one of the most sophisticated processes that we hope to develop during the whole course of education. By developing writing skills along the lines suggested, one would simultaneously be addressing what is felt to be a widespread problem, ie inert knowledge or passive knowledge integration.

On a meta-evaluative level, what is compelling about this approach is the thoroughness of the integration of the theory and the implementation. Although, for example, the researchers could choose specific exponents of "diagnosis", as long as these categories are viable components of the executive or self-regulatory function, further development of this approach might lead to a plethora of terms, and consequently a need for their theory-related appraisal.

The question of transfer here would be asked in reverse: by this we mean that when we have made a discernible gain in writing skills, we might be tempted to ask what gains have been made in thinking skills. The fact that the concrete aspects of facilitation described above seem to be so straightforward should not obscure the underlying conception of expository writing as an example of a high order, complex, cognitive process.

This section, thinking through language, seems to provide promise in terms of the model that we drew up in Chapter Two. To go through the questions we drew up:

1. This approach helps us to understand the nature of much of conventional schooling learning, and why it is unproductive when applied beyond itself. It also helps us to understand the nature of complex school tasks: however, from informal observation, it seems that ex-

tended expository writing (such as a "project") could not be expected before a child is 11 - 12 years, so perhaps attention should be focussed on shorter tasks. Without doubt, the challenge of doing such tasks in the second language is of greater complexity than they suggested for first language learners.

2. Aspect of cognition in IPS terms are related in an illuminating way to the task demands of formal writing; the analysis lends itself to further development.

3. The role of teacher as mediator is not spelt out clearly; however the role of the resources as mediator is theoretically motivated (in terms of self-regulatory mechanisms) and might constitute the seeds of a developmental programme in our situation. Using external regulatory mechanisms of the kind described should enable teacher adaptation to the complex task as well.

4. The children in the research described seemed to recognise the efficacy of external self-regulatory mechanisms. The interventions appropriate to the child should be easily predicted for a variety of tasks.

3.5 THINKING ABOUT THINKING

3.5.1 General characteristics

Teaching *about* something is not necessarily an effective way to teach somebody *how* to do it. This applies to thinking as much as it applies to skills like piano playing (cf. our discussion about procedural representations in Chapter 2). However, Nickerson et al (ibid) feel that these approaches have obviated the difficulties by making an alliance with heuristic and language approaches, often emphasising linguistic products like arguments and offering advice on how to proceed as well as practice in doing so. Looked at from the other side, it would seem to be particularly apt to supplement straightforward teaching of heuristic and language skills with an understanding of their motivation in human psychology and in epistemology (but this only with advanced level students).

If one thinks about the previous approaches that we have described, we found that some teaching about cognitive operations did seem to have benefit in the Instrumental Enrichment approach, while it was not deemed to be necessary in the process skills approach. However, in de Bono's CoRT, children are taught explicitly when to use their different strategies. In the formal operations approaches, students are not taught about the Piagetian formal operations per se , but they are taught to approach their subject matter more actively, with higher-order process skills.

Looking at approaches to writing, it was found that children could not always use information about writing during the actual process, and hence needed external aids.

One programme that we are not going to describe here i.e. Philosophy for Children actually take frequent recourse to philosophy, particularly epistemology, learning about what constitutes adequate grounds for knowledge and belief.[6] Nickerson et al feel that philosophical emphasis is a benefit insofar as it comes with a style of critical thinking and careful attention to language.

We have promised in an earlier chapter to look at metacognitive skills in this section, especially as they pertain to reading.

3.5.2 Metacognition, Executive Control, and Reading Comprehension

Reading, as we have seen, is a complex cognitive task of immense importance in school settings. It is the instructional domain to which psychologists have paid a great deal of time and attention. Recent insights about its interactive, constructive nature (cf. Garner, 1987 for a review) places a great emphasis on an active learner who directs cognitive resources to direct a task. So it is not surprising that there is possibly a rich application of metacognition and executive control theory research on reading, for they would have a particular interest in activity in which the active learner optimizes her own learning.

Perhaps the two most replicated results of recent years tying metacognition to reading are :

1. Younger and poorer readers have little awareness that they must attempt to make sense of text; they focus on reading as a decoding process, rather than on a meaning getting process (Baker and Brown, 1984, p.358), and

2. younger children and poorer readers are unlikely to demonstrate that they notice major blocks to text understanding. They do not seem to realise when they do not understand (Garner and Reis, 1981, p.571).

A large number of interview studies and error detection experiments have yielded these robust findings.

More recently, readers' strategic repertoire differences have been studied from a metacognitive perspective. Because of the modal sequence of

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6 The work of Strohm Kitchener (1983) on the difference between metacognition and epistemic cognition has relevance here, although epistemic cognition is generally regarded as being acquired later than middle childhood.

metacognitive experiences, prompting action that is cognitive and metacognitive we would expect to find that younger and poorer readers are likely to deal more poorly than older, more competent readers in this sequence of comprehension monitoring and employment of compensatory strategies.

The strategies that have received recent research attention are:

+ Text reinspection to remedy memory failure (Garner, Macready & Wagoner 1984);

+ studying text segments previously found difficult more extensively than easy segments (Brown and Campione, 1977); and

+ summarising succinctly just the important statements from expository text (Winograd, 1984).

As Ryan, Ledger, Short and Weed (1982, p. 54) note, "Comprehension problems among unsuccessful readers with reasonably adequate decoding skills are often related to their failure to participate actively and strategically while engaged in the reading process".

According to Garner (ibid, p.29), we do not have any greater clarity for reading than we have for other cognitive activities about the relationship between knowledge and performance, about the relationship between "knowing" and "knowing about knowing", or about the spontaneous development of metacognition in the area of reading.

However, we do have descriptive information about individual differences among readers of different abilities and ages in metacognitive knowledge, metacognitive experiences and strategy use (or executive control). Most interventions have been with children who need general remedial assistance in reading.

We do know something about the differences in metacognitive knowledge amongst children of different reading competencies. An interview study by Forrest and Waller (1980) on children in grades 3 to 6 showed an increase in metacognitive knowledge about decoding, comprehension and reading for a purpose with both higher grade and reading achievement level. The more competent readers knew that what a word says is not equivalent to what it means, they knew that self-test strategies are helpful in getting ready for a test, and they knew that "strategic" behaviours are important for study reading, if not for reading for pleasure. The deficiencies of the younger, poorer readers seem to be both in the declarative and procedural knowledge categories. Another study by Paris and Myers (1981) also made an attempt to assess knowledge and performance in the same group of children. They found evidence of a relation between faulty knowledge of appropriate strategies, and poor recall performance.

Another study (Garner and Kraus, 1981-1982) also linked knowledge and performance. Using seventh grade children, they found a significant dif-

ference between good and poor readers. A sample of responses illustrates the distinctly different emphases found in the two groups. To the questions "What things does a person have to do to be a good reader?" good readers gave such responses as "understand what you're reading" or "getting the ideas", whereas poor readers provided such answers as "pronounce the words right", or "know all the words". To the question "If I give you something to read right now, how would you know if you were reading it well?" good readers responded well with "if I could understand without reading it over and over again" or "if I didn't have trouble getting the point". Poor readers responded to the same question with "if I don't pause much" or "if I read fluently out loud". Finally, to the question "what makes something difficult to read?" the good reader responses of "if you're not familiar with the important ideas" or "badly written stuff where the ideas are hard to get" can be contrasted with "small print", "a lot of big words", or simply "long words" mentioned by poor readers.

We need to be able to explain these differences. While it might be thought that a lack of school experience accounts for missing information and misinformation, Garner and Kraus (ibid) suggest that in-school experience itself may account for some of these knowledge problems. Instruction strongly affects the pupil's perception of the reading process, and early reading experiences emphasise oral reading and decoding. They also suggest that good readers experience the "magic" of reading for meaning, and so alter their perceptions of the ultimate goals of the process: poor readers, on the other hand, who have never experienced this "magic", have a poorer idea of what the purpose of reading is, and so continue to hold on to decoding emphases when trying to improve their reading performance. It may be that good readers quickly get a chance to pursue meaning-oriented reading even in the classroom, while the poorer readers get stuck at the point of reading accuracy. This was certainly the impression we gained in our classroom based observations, with only one Grade One teacher having the insight to insist that poorer readers should gets lots of practice reading easy readers, so that they can experience a feeling of success, and presumably also learn to automatise their decoding skills.

In our section in the previous chapter about cognitive monitoring (2.3.2), we made reference to research which found that children do not readily report errors and inconsistencies when they are reading. These kinds of studies are called error-detection studies. Garner (op cit) summarises the convergent findings of the research. Firstly, many of the errors go unreported, even by adult subjects, even in situations when analytical processing is encouraged and reinspection of text is sanctioned; second, more experienced and more proficient readers were better than poorer readers during such error detection tests, and in reportbacks on their experiences.

The fact that there seems to be an absence of metacognitive experiences is rather worrying given that textual errors are a common phenomenon. Armbruster and Anderson (1981) have noted that school texts (which are supposed to underpin school instruction) are often "inconsiderate": that is, they require readers to expend extra cognitive effort to compensate for authors' failures to provide adequately structured, coherent and

information-appropriate text. Examples of aspects of inconsiderate text are:

+ A mismatch between structural signals such as headings and topic sentences and the content that follows;

+ short choppy sentences that obscure relations among ideas;

+ insufficient information given the probable prior knowledge of readers;

+ irrelevant information which potentially distracts readers, and

+ an absence of definitions for difficult vocabulary words.

If readers do not notice blatant errors in research material, they are surely not likely to notice and seek remedies for some of the problems found in "inconsiderate" school materials. Research done on the Threshold Project (cf. Disparities Final Report) has shown up some of the difficulties of inconsiderateness even in texts that children find relatively easy to process.

In section 2.3.2 above, we also mentioned that "metacognition" was a term that had been widely used and probably abused; and the same could be said about one aspect of metacognition, namely "strategies". This term has referred to complex and simple activities, those imposed and those learned spontaneously, some highly routinised and some very consciously applied. Garner (ibid) has tried to restrict the term (and so tighten our understanding) to refer to those strategies *that are generally deliberate, planful activities undertaken by active learners, mostly to remedy perceived cognitive failure.* Of course, learners must know when and where, as well as how, to use them.

It seems that there is very little direct instruction in Western primary schools on reading comprehension. Durkin (1978-1979) found that only 1% of instructional time on reading that she observed was devoted to direct comprehension instruction; in a follow-up study she found that teacher's manuals generally paid scant attention to direct, explicit comprehension instructional suggestions. Our own experience with English second language teaching schemes, is that they too, with one noticeable exception, do not focus on techniques of reading comprehension. The fact that teachers find it very difficult to use the one course that addresses itself directly to reading processes suggests that the teachers simply do not know and probably have not been taught, how to teach reading comprehension, and that the teachers themselves may well be lacking in higher-order reading skills (cf. Johanson, 1985).

Garner (op cit) reviews some 70 studies on the teaching of strategies on reading and concludes that there is considerable optimism about the possibility of teaching strategies. Two issues of overarching concern are that the use of strategies should endure, and that we should discover why people "choose" not to use strategies anymore. However, from our perspective, i.e. from the small child learning to read in the second

language, we cannot reach such a positive conclusion.[7] For one thing, there is very little research about young ESL children learning to read, and about whether this process neatly parallels what is known about the L2 learner.

There are important questions that we need to answer about the relation between L1 and L2 reading, for example:

1. If we teach strategies such as comprehension monitoring in the L1, will these automatically transfer to the L2?

2. If such strategies fail to be taught in the L1, how much more difficult would it be to teach these in English?

3. What are the critical attributes of L2 content subject textbook that would facilitate the task of the ESL learner?

The first two question contain the presupposition that teaching reading will naturally be in the order L1, L2. However, in certain bilingual contexts, this presupposition does not necessarily hold (Mason and Au, 1986).

It would perhaps be premature to apply insights from American research on metacognition and reading to our context without further corroborative research. And these questions will have to be contextualised in the larger issue of what it involves to become literate in the second language. In this enterprise we shall have to contextualise our research in the dynamics of the learning situation which prevail, (and here the Threshold Project has already broken ground) and try to co-ordinate this with the descriptive tools which will help us to analyse how it is that children best make the transition from the decoding stage to reading for meaning. The descriptive tools for the second half of the enterprise we can sharpen from the set which the IPS approaches already supply. (There is an extended discussion on learning to read, in the English Language Skills Evaluation Final Report.)

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7 For example, we can identify with the following strategy identified by Adams, Carnine and Gersten (1982) for retrieving information in text books:

   1. Preview the passage by reading the headings and subheadings.
   2. Recite the first subheading.
   3. Ask oneself questions about what might be important to learn.
   4. Read to find the important details.
   5. Read the subheading, reciting important details.
   6. Rehearse (as a final review and check of task readiness).

   This is probably a very effective strategy, but the sort of thing that ESL learners even at a tertiary level might have difficulty with.

3.6 SUMMARY APPRAISAL

In this section, as in the previous final section on intellectual competence, there will be no attempt to systematically summarise what we have discussed. Rather, we will attempt to briefly set out the crucial issues.

We will structure our summary around a set of questions about basic assumptions, and ascertain where our own would be accommodated. The questions are as follows:

1. To what degree are questions about the relationship between culture and the curriculum made explicit in the programme?

2. What are the important aspects of cognition to be taught, and what type of gains are to be expected? How are these aspects related to the task of schooling?

3. What kinds of competencies would be assumed of the teacher? What training would she need?

4. What is expected of the pupil?

1. Culture and the curriculum.

As we mentioned at the beginning of Chapter One, work on thinking programmes has scarcely considered the cultural context in which such work could be implemented. Feuerstein is a notable exception in taking cognisance of what he calls "cultural deprivation" which occurs in the absence of effective mediated learning experience. Impoverished mediation may occur during a period of rapid social transition. (This is a point made most articulately by Craig cf. 2.7.1 above.)

However, the completely implicit and unexplored assumption is that Western-style thinking (at its most integrative and innovative) should be facilitated. Nobody would dream of facilitating context-sensitive, associative thinking such as described by Kok (1986). the superiority of Western patterns of thought is assumed. While this approach would hardly be favoured by cultural relativists, it may be that a truly innovative conception of change may do due justice to all aspects of a culturally-diverse situation (cf 1.3 above for an explicit discussion).

One could adopt a notion that in a multicultural society, social life is best interpreted as Malinowski's (1945) "third cultural reality", which is constructed in the transaction between contributory cultures. While a core curriculum of "logic" and "science" could be assumed, the movement towards the genuine integration of this would be in the social processes of negotiation of differing value systems, social practices, and current power dispositions.

Such an orientation could obviously not be contained within a "teaching thinking skills" programme. We would be moving towards something that is a great deal broader, and rather less instrumental.

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2. The aspects of cognition to be taught: their relation to the task of school learning.

The usefulness of the framework that Nickerson et al offered us lies in the different aspects of cognition that are to be focussed on. For example, Instrumental Enrichment focusses on basic cognitive operations (eg comparing, classifying, etc), but it seems that changes in school performance (a secondary objective that could be considered to be reasonable) were probably mediated by changes in motivation and self-concept. Heuristics-oriented approaches teach strategies for dealing with problems that are supposed to be applicable across many domains: however, the transfer of such skills might be difficult, and the most useful time to teach such skills (bearing in mind what we know about metacognition) might well be late-childhood. The thinking through language approach (not a programme per se) would take writing as an instance of complex cognitive activity and model aspects of its planning and execution. Effective development and application of these insights, generated primarily within the IPS paradigm, would promise potentially significant insights into teaching writing skills, an aspect of the curriculum which we cannot afford to overlook.

Similar remarks apply to new insights into the teaching of reading within an IPS approach. The massive body of literature on the different "stages" of learning to read effectively is ignored, especially in the ESL context. However, we would have to assume that basic research on children's metacognitive knowledge, experience and strategies (or skills) in the first language would have application at a similar developmental level in L2. Although it may seem pedestrian in the light of new jargon intrinsic to the "teaching thinking skills" industry, to require of one's pupils to be able to read for meaning, to read critically, and reflect on one's reading, these would be ambitious aims in terms of language teaching, but aims that we cannot risk neglecting.

Our appraisal would be that we should set our sights on the heart of the "core" curriculum with its complex cognitive activities of reading and writing. If we have to legitimate the traditional concerns of the curriculum by demonstrating the complexity of the processes, we have the descriptive tools at our disposal.

3. The kind of competencies assumed of a teacher.

In order for a teacher to teach something new, she must become acquainted with the new system. If what is required in the new approach is dissonant with what the teacher herself is able to do and understand, we will find that the teacher will either transform the task into something she herself can do and understand, or else she will proceed by imperfect analogy, which mimics the surface structure of the task, but fails to discern, construct and communicate that which was originally intended. In either case, the new approach will become recognised by its most highly idiosyncratic or salient characteristics, and the buzzwords and jargon will circulate to mark membership of a new elite educational subgroup.

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What characterises all the new approaches to *teaching thinking,* is what characterises the "new" approaches to teaching per se, and that is, the teacher must not use the lecture method. Rather, the focus should be on pupil participation, guided exploration, and discovery. We have explored, both in this report and the School-Based Learning Experiences, what the cultural constraints serving to maintain rote receptive learning are, and what the particular model of child-centredness is that the PEUP has evolved in the junior primary, a model that is entirely consistent with the cultural parameters that we have identified. What we have discerned is that it is highly unlikely that there would be any rapid shift in learning styles that will have a radical effect on thinking styles, despite the best efforts of upgrading projects to date.

In relation to the teacher, we would surmise that there would be a marked difficulty in teaching heuristics that are any more demanding than some of the CoRT strategies eg PNI - what is positive, negative and interesting about this idea. But we should not underestimate the repeated use of such seemingly simple strategies, across a range of concepts, over an extended period of time. What would be likely to happen would be a subtle reorientation of attitude towards knowledge: no longer to be regarded as a body of facts, but rather as ideas which can be debated and analysed from an individual or perhaps group (consensus) point of view.

However, a strong principle that we have been able to extract from a combination of research and experience is that it does no good at all to teach teachers in any depth about theories. For example, our own attempts to inculcate the notions of process skills met with a blank wall of incomprehension, our conclusions were that the materials should provide a springboard of essential process skills embodied in questions, and that, hopefully, continuing practice with this type of material would lead the teacher to add innovations of her own.

We referred, in the section on expository writing, to an IPS concept of developing the cognitive system by means of change-inducing agents. What this means here is that the teacher will not learn new rules of task performance but rather acquire them in activity. The new self-regulatory functions that the teacher will acquire (cognitive and metacognitive knowledge, experience and strategies) will be mediated by materials, which in turn are mediated by models. In other words, teacher education will move through its own ZPD, as teacher trainers will model new teaching, gradually revealing the deep structural demands of tasks, so that teachers can become aware of the demands themselves, and can begin to mediate these themselves to their pupils. But just as the individual's ZPD shifts with learning, so should the ZPD of inservice training shift too. In other words, it should be a conscious strategy on the part of teacher training planning that feedback from easily modelled change should inform the next cycle of more sharply focussed, analytical training.

4. What is expected of the pupil.

In terms of the learning-in-context model that we examined very closely in Chapter Two (cf. 2.7. on the Vygotskian paradigm), we are not altogether optimistic about any externally imposed attempts to get the child to change his role within the collaborative and reciprocal paradigm that is indigenously based. As we indicated in the previous section, the thinking skills programmes that have been formally developed really require the child to become what Craig calls an "autonomous problem solver." Yet his role as currently defined virtually proscribes this.

What would be required is that a gradual transition be negotiated, by interaction and transaction, within the school system per se, in the direction of the child's being enabled to develop self-regulatory mechanisms. In terms of curriculum planning general target objectives for the child would be developing executive functions in different domains, including for example, checking, planning, monitoring, revising and evaluating. The review of the work of Bereiter and Scardamalia has shown us how ambitious such a programme would indeed be.

The power of the IPS approaches is that they can show to us how it is that "inert" knowledge is constructed, knowledge that is not interrelated in any meaningful way with other knowledge. The knowledge-telling strategy model, were it to be refined, would serve as powerful description of the kind of learning that is typical in our situation. Indigenous patterns of learning combined with a content-heavy curriculum will both serve as powerful constraints on the development of generative learning.

Yet, as we have discovered from the literature and from our own research experience, children are adaptable: despite teachers' opinions, they are much more likely to accommodate to the teaching and class-management style of the teacher than the teacher is to accommodate to them. And if the children's homes are currently not effective mediators in the change process, then teachers are going to have to bear an unduly heavy burden in this regard. The teachers are going to need all the support they can get.

But we should not expect too much from the child either. The past decade has shown us that the primary achievement of middle childhood (as the child consolidates his concrete operations) is the development of the different facets of metacognition. Cross-cultural research in this developmental area is in its infancy, but we may yet find, that by anybody's standards, we are expecting too much from children. Markman's rather startling findings on comprehension monitoring should alert us to the need for exercising the patience of true child-centredness. For a long while, children seem to take the world "as it is", without too much conscious or automated monitoring that would notice inconsistencies that they can derive from logical inference. For, to notice inconsistencies children would have to carry out the following processes:

1. Encode information,

2. store it,

3. draw relevant inferences,

4. retrieve and maintain inferred propositions and

5. 'compare these inferred propositions.

Asking the child to do all this spontaneously at ten years is one thing; asking him to do it at all in his second language is asking him to do something well beyond this.

In the final chapter of this report we will examine the contribution of bilingual education theory to our problem domain. Once again we will be applying the outline of the model we developed in Chapter Two.

CHAPTER 4

SITUATIONAL ANALYSIS OF BILINGUAL EDUCATION IN A DEVELOPING CONTEXT

In the introduction to this report, we described a primitive model that showed that there is a dynamic relationship between language, cognition and education in the context of culture. The culture reproduces the structures of cognition and education and determines how these structures interact with language learning, in both natural and formal acquisition. (Cognitive and educational structures can, in their turn, transform cultural structures.) The fact that the child has to learn through two languages makes his learning task much more complex. That much we know, but we do not yet specifically know in cognitive terms much about *how* the task is made harder, nor do we know specifically how to make the task *easier* in these same, cognitive terms. It is because of this difficulty that the two language-bilingual education issues were not brought directly into discussion in the body of the report. Even Section 3.6 above, which addresses basic assumptions of an approach to the teaching of thinking skills, leaves out the issue of the change of learning medium. But, since the core problem of the Threshold Project research concerns the difficulties surrounding the change of medium, the issue is taken up in general terms in the following discussion. However, it should be borne in mind that *we are interested in ways of enabling children to learn effectively, and this interest starts with their earliest learning experiences and goes beyond the official introduction of English as the medium of instruction.* Stated in another way - if we can demonstrate that formal language learning is an instance of a more general formal learning pattern, then we can make more powerful statements about the child's general learning domain.

An area of common concern in educational writing is how teachers construe learning: the average teacher is supposed to be far behind the radical constructivist thinkers such as Dewey, Polanyi and Piaget. Constructivism is generally not supposed to have reached the average classroom, whether it be African or Western. Rote learning is seen to generally prevail: this learning leads to inert knowledge, which was described and analysed in Chapter Three above. In the same way, the "Grammar-Translation" (GT) method in language learning encourages learners to memorize vocabulary, and learn grammatical paradigms and rules that are supposed to be used in a hypothetico-deductive way to generate more examples. However it is a well-known phenomenon that the GT method does not generally lead to real generativity in language use. Partly as a response to the failure of the GT method to prepare learners for real-life language situations, the Communicative Approach (CA) was developed. This approach has as its aim to make the learner communicatively competent - using language appropriate to a given social context. To simplify the history of the CA (and perhaps to underrate it), it seems to have regarded the social context as *that which is outside of the classroom.* Of course, this is a valid social context, but the CA is going to have to extend its criteria of intentionality, authenticity and purposefulness to activities which are intrinsic to the classroom learning situation. This is where more general analyses of the child's learning task can become helpful. For example, I perceive

real parallels between writing on process skills learning in early general science (cf Zeiler and Barufali, 1988) and writing on teaching cognitive and metacognitive strategies in general classroom instruction. What is the most heartening of all is to see extensive and authoritative writing on the integration of strategy learning with content subject instruction O'Malley, 1988. On such an account we get a loosening of the concept of content, from a body of facts to be learned in way x,y, or z, to a dynamic concept of content which is to be seen as part of the process. We shall be taking up this point again towards the end of this chapter (with an example of vocabulary learning).

The Vygotskian notion of a cultural mediator or guide has had rich application in our thinking. However, it leads us up some narrow paths, from which only Craig's work can provide the escape; for example, given the assumption that the teacher spontaneously mediates her culture in her transactions with her children, we would need to be able to ask and answer questions like, (how) can a teacher mediate a second language in such a way that she mediates only the connotative meaning, so that the language becomes an abstracted tool for thought? This conundrum has been put more generally as follows (Okaya-Lakidi and Mazrui, 1975):

One old question for the educator to answer anew is this: to what extent is it possible to import Western technical and technological skills without at the same time importing also such aspects of the Western way of life as are relevant and necessary for the use of such skills? Furthermore, to what extent might such skills devoid of their relevant Western cultural accompaniments, succeed in the African cultural context?

A tentative answer to this question (which is addressed again in our Consolidated Main Report) is that it would be difficult to mediate anything other than that which one already is, and therefore the teacher herself (as both an adapted and an adapting system) will have to undergo continuous transformation to begin to mediate another reality (at the very least, the "third cultural reality" we mentioned in 3.6 above). At a superficial language level, there will of necessity be a progressive Africanisation of English (a fossilization of specific forms of black English), unless there are meaningful transactions with mother tongue speakers of English. The solution here lies at a political level.

At the level of teaching concepts, if the teacher does not have a clear idea of the concept herself, or if she cannot explain the concept in English very well (and the two might reduce to the same in practice), then the child will develop ill-formed or woolly concepts himself. The question of the degree of what might be called spontaneous Africanisation that South Africa's purportedly western education can absorb and still produce people that the larger society calls educated (in some broad sense) or skilled (in some narrow sense) is one of values, one that cannot be answered easily at an analytical level at this moment. At an analytical level we can know that the adapted system (western education) can and may be changed by the adapting system (black education).

To turn from the focus on the mediator to a more broadly educational focus now, in order for developmental theories to be of help, they would have to give an account of general modes of knowing and interaction, as well as of the nature of specific learning tasks. We need to be able to co-ordinate specific information about modes of knowing with the demands of the tasks, specifically reading, writing and mathematics. To make rather a pedestrian point, children obviously bring thinking skills to bear from the first day of learning to read and write; they also bring specific adaptive skills to bear on the demands of a new environment. Also at a broad level, we have an account of the junior primary child as preoperational or concrete operational; what the child brings to the learning situation is an innate sense of curiosity, and a drive towards social negotiation, which is part of a large drive towards the creation of meaning.

The notion of "thinking" and bilingual education have not been brought together in consideration of the curriculum per se. We do know that the bilingual child is supposed to be cognitively flexible, for example in terms of making metalinguistic judgements especially if his language skills have been acquired in naturalistic situations (cf. the seminal paper by Peal and Lambert, 1962), but only if he is bilingually proficient. [1] Herein lies the sting: children are not becoming proficient in English (as we know from our own investigations, cf. the English Language Skills Evaluation Final Report), and we feel great concern for the particular cognitive demands of the bilingual education curriculum; it is possible that we are producing semi-lingual children who can't use language to formulate and negotiate concepts. In the terminology of bilingualism theory, children using the high status language as their medium of instruction are good candidates for "subtractive bilingualism". Working with children in an additive bilingualism situation (where the first language is a majority, high status language), Malakoff 1988) has been the first to try to show that the language of instruction has language-specific effects on academic, context-reduced tasks. In our situation this would translate to a child being able to do something such as disambiguating sentences more readily in a well-established medium of instruction rather than his mother tongue.

We need to be able to narrow our discussion about language and the learning demands of the curriculum to terms that provide some direction for action. There are some recent developments in bilingual education research which will be of help in our task analysis. The first pairs of concepts that will help us are the cognitively undemanding/demanding and context embedded and context reduced parameters. This contrast is reproduced in Figure 4.1 below, which followed on initial distinction be-

[1] Malakoff (1988) commenting on work in the Peal and Lambert tradition, point to a serious analytical error that may have been committed: "balanced bilingualism" is supposed to result in "cognitive flexibility" - but it is possible that children who have become balanced bilinguals might be intelligent or have a gift for languages - it is not possible to separate out the two variables.

tween basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP).

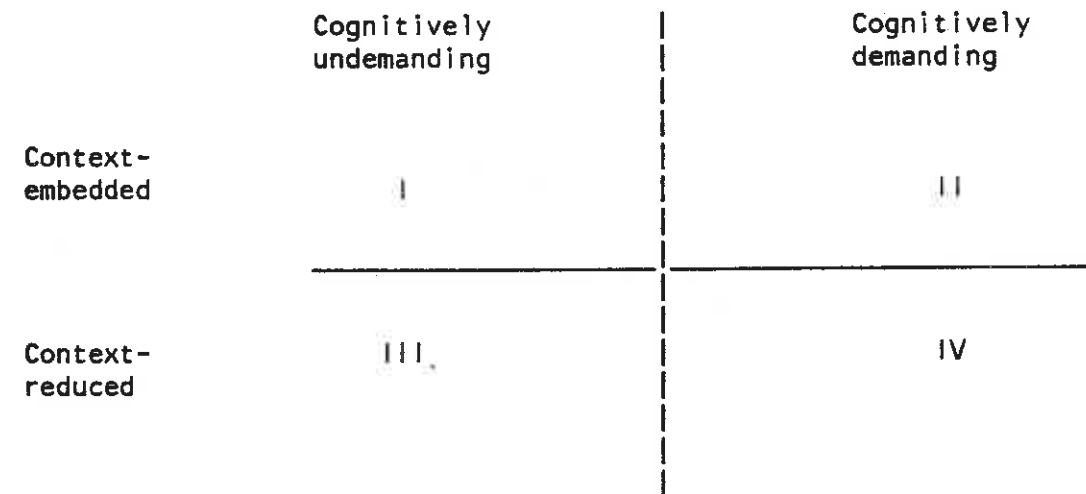|	Cognitively undemanding	Cognitively demanding
Context-embedded	I	II
Context-reduced	III	IV

Figure 4.1 Range of contextual support and degree of cognitive involvement in communicative activities (Cummins, 1983)

Let us first assume that children need to develop what has been called cognitive-academic language proficiency in order to succeed at conventional school tasks. This kind of language proficiency is required in situations that can be defined firstly in terms of being context reduced i.e. the concepts are remote from the learning situation, and abstracted in terms of written language; communication relies on linguistic cues to meaning, and so the language must be elaborated precisely and explicitly so that the risk of misinterpretation is minimized. On the other end of this concept continuum, we find context embedded communication. This type of communication derives from interpersonal involvement in a shared reality, which does away with the need for explicit linguistic elaboration of the message. This communication is more typical of the everyday world than that of the classroom.

Cognitive academic language proficiency is also defined in terms of being cognitively demanding (rather than cognitively undemanding). We can talk about cognitive involvement in terms, for example, of the amount of information that must be processed simultaneously by the individual in order to carry out an activity. This concept will apply to language learning in different ways, for example, when the child enters school, the first cognitively demanding task that faces him is to learn to read and write, and very soon, to start to learn the sound system and words of English. Later on, what is cognitively demanding, is processing rather more difficult English which embodies new and unfamiliar concepts. We have also described expository writing in Chapter Three as a cognitively demanding task. The child's developmental level will also define what is cognitively demanding, therefore this parameter "demanding - undemanding" will shift with time, development and learning.

To use English as a medium of instruction, one needs cognitive-academic proficiency in it. One way of getting to this kind of proficiency might be through cognitive academic proficiency in the mother tongue.[2] This point of view is based on the evidence that some aspects of first (L1) and second (L2) language proficiency are interdependent. That is, they are manifestations of a common underlying proficiency. To show more clearly what this means, let us look at the 'dual-iceberg' representation of bilingual proficiency (Figure 4.2).
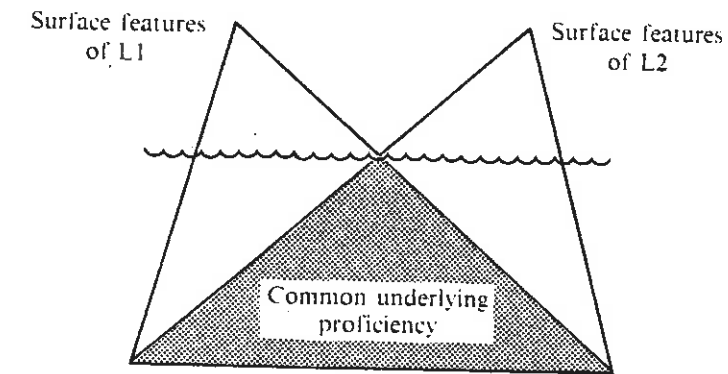
Surface features of L1 / Surface features of L2

Common underlying proficiency

Figure 4.2. The dual-iceberg representaiton of bilingual proficiency (Cummins and Swain, 1986).

The dual-iceberg notion is not tied to language universals, rather to commonalities of learning through language, and we suspect, specifically, literacy skills. Let us look for example, at one level of learning to read, i.e. phonics. The ability to isolate phonemes in a word, to segment and synthesize these are all important in learning to read an alphabetic language. We would expect that sound teaching of phonics in the mother tongue will prepare the child for phonics in the second language, even though the phoneme-grapheme relationships will be partially different. At a much higher level, if the child has learned the conventions of expository text (e.g. headings being predictive, the difference between a heading and a subheading, the purpose of an overview or a summary) in his mother tongue, then there will be no need to teach it to him again. However, we suspect that there is at least two other levels that would exist in this common underlying language proficiency (CULP).

The written functions of cohesion, at a lexical level (with semantic fields for example), at the level of logical connection (even though the exponents of cause-effect relationships for example are not the same), and even at the level of ellipsis and substitution, while not isomorphic across English and the African languages, would at least seem to have

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2   The discussion of the relationship between the two languges does not take into regard practical issues like learning time for the two languages, and the ability of the teacher to teach in both.

parallel functions. Having learned the functions, albeit explicitly in the one, would lead to certain expectancies when approaching the L2 text.

The last level which I should like to speculate on is what would be the effect of L1 literacy for clarifying the spontaneous concepts of the child. When the child can recognise and identify her everyday experience in print, there must surely be some internal organisation of everyday concepts, organisation which, incidentally, is common to that language and culture. The child can then go on to make language the vehicle for the further development of the organisation of these concepts. If formal second language learning comes in too soon and attempts a reorganisation of cognitive structures through imperfectly learned and imperfectly understood linguistic (including semantic) structures the effects of the spontaneous clarification in the L1 will be prevented. (We fully realise that this last point is probably inapplicable to natural L2 acquisition, in which the child, from the earliest stages seems to be comparing and contrasting concepts and expressions in the two languages, if their spontaneous comments are to be relied on as a source of evidence.) In the final analysis, the better one understands one's own point of view, the better one will understand another: conversely of course, the better one understands another's point of view, the better one understands one's own - a basic precept of cross-cultural research.

What we would be arguing for then is that the child be able to acquire the tools of literacy in his mother tongue, and be given the chance to develop them while beginning to become literate in the second language. The development and maintenance of mother tongue literacy skills would then serve to support the same in English. However, this theory is predicated upon the use of what I call a robust language programme, one that teaches children the full range of communicative language skills, but at the same time also thoroughly inculcates what the language has to offer in the way of expressing spatial, temporal and logical-causal relationships. Endless attention to the form of proverbs (as is now common in the African language teaching) should for example, be replaced by a dynamic analysis of these as a way of revealing the underlying values and motivations of the traditional life.

The Cummins-Swain (1986) model is supposed to give an account of the task of the first and second language learner alike. In this way we can see how the task of the L2 learner has to parallel that of the L1 learner, while the latter is learning another language at the same time. This model should do much to develop communicative language teaching principles towards using the language as a medium of instruction: an urgent enterprise. O'Malley (1988) has developed the model further, giving examples of tasks that will occur in each of the four quadrants, and we have taken on the challenge and added further viable examples. I have called this model the transition from ESL learning to CALLA learning, and it is reproduced at Figure 4.3 below. Children should start out in quadrant one when they enter school, and end in quadrant four by the time they are in Standard Three. The quadrants are not mutually exclusive - that is, one can continue to engage in tasks that are cognitively demanding but context embedded: if we fail to recognise

this, we would be making the same kind of error that people have previously in saying that adults always engage in formal operations.

Cognitively undemanding	Cognitively demanding
I *Context-embedded* Language drills with context Face-to face conversation on formulaic lines, later, simple topics Following demonstrated directions Keeping a diary Playing a simple game, where roles and routines are modelled Art, music, physical education, where model has been presented Vocational subjects e.g. woodwork, where skills may still be learned by imitation	II Demonstration of a process Content subject explanation with demonstration Answering higher level questions e.g. temporal sequence, cause-effect relation Making oral presentations Hands-on science activities Maths - computation problems Maths - word problems with concrete objects or pictures Heavily illustrated textbooks Making models, maps, charts
III *Context-reduced* Uncontextualised language drills Answering lower level questions Writing answers to lower level Predictable telephone conversations Shopping lists Recipes Informal note/message of predictable topic Directions for taking medicine Copying words and sentences Filling out simple forms Writing simple narrative of personal experience (knowledge telling)	IV Content subject explanation without demonstration Reading comprehension without textual support Reading for information in content subjects e.g. to extract topic or main ideas Maths word problem without illustration (with increasingly difficult syntax) Compositions, essays, on topics immediately outside pupils' experience Research and report writing where different information sources need to be consulted Writing answers to higher level questions Standardised achievement tests

Figure 4.3 Classification of language and content activities (extended from O'Malley, 1988)

Part of the Cognitive Academic Language Learning (CALLA) Approach being opened up by O'Malley involves the use of strategies - cognitive, metacognitive and social-affective. The CALLA approach is intended for use in the higher primary to junior secondary phase, and hence we may therefore not be able to apply literally what O'Malley offers. Furthermore, his claim that the same strategies apply to language learning and content subject learning is clearly worth <u>very</u> close attention (more is said about this is the English Language Skills Evaluation final report).

We would like to look at two critical aspects of the CALLA approach, i.e. asking questions, and metacognition, before we go on to look at the role of teacher as mediator in CALLA.

It is considered of primary importance in CALLA that the child is taught to ask questions for self-clarification. "Minority" children tend not to ask such questions, nor even realize that to do so is appropriate behaviour. In our own research, we observed very few questions for self-classification - and teachers said that the only way to find out whether the children understood something was to give them a task to do which in some way involved this learning. Jahoda (1986) in his review of cross-cultural developmental psychology cites the asking and answering of questions as culturally sensitive (in Craig's terms, we would talk of enabling conditions for learning that vary). Adults can ask children questions if they want "genuine information"; however, they can also ask questions which have a command function (e.g. *When are you going to wash your face?*). Children may ask questions for information, if by doing so, they do not appear to be appearing to challenge their superiors.

Bruner (1985) would have it that all forms of external negotiation of meaning, all external prods to reflection have the effect of stimulating internal negotiation, reflection and metacognition. What we are leading up to here is the possible path cognition could take from externally regulated agents (teacher, materials) to internal cognition and then monitoring of one's own cognition, which after all, must be the simplest form of metacognition. Bruner (ibid) is able to put the developmental process thus: the younger child doesn't know explicitly enough what he knows in order to be able to tell whether he is being consistent in organising information. Chunks of information must become routinized for him to combine them; only then comes awareness. Self-regulation must become the key to effective learning during the course of development.

The mediational operators that we can extract from CALLA for use in the junior primary phase would include the following:

1. Provide advance organizers - structure the task in terms of the knowledge that children already have.

2. Make the new input comprehensible to the child.

3. Structure the task in terms of cognitive strategies within the child's repertoire, including grouping, imagery, making inferences, asking questions for clarification.

4. Encourage the use of emerging metacognitive strategies including self-monitoring with external aids that can be internalized.

In concluding this report I should like to outline the beginnings of a task analysis of one language skill that applies across both languages. In the language of the model constructed in Chapter Two - we are working here with expert rules for being and ideal ways of doing tasks. The "expert" here is Sternberg, who as part of his conception of knowledge acquisitons the need for <u>learning vocabulary from context</u>. In the language of information processing the organism busies itself with selective encoding, combination and comparison. In terms of the vocabulary learning context, this means that the learner must see the new vocabulary items as the centre of a network of information, and seek out cues (which we look at below) within the sentence or in surrounding sentences. The cues are then combined in such a way as to start building a plausible description of the meaning, and what is being constructed is compared with what has been learned in the past.

The cues which the learner must come to recognise and use include the following:

1. Setting cues (including time, space and situational information).

2. Value-affect cues (whether the word has positive or negative connotations).

3. Stative property cues.

4. Active property cues.

5. Causal-functional cues.

6. Class membership cues (what is related to).

7. Antonymic cues (what it is contrasted with).

8. Equivalence cues (what it is informally equated with).

These cues operate spontaneously or consciously in the construction of word meaning. They have bearing on:

+ the writer/speaker of the text (who must keep the density of new words to a minimum, and only use new words when they are important to the content),

+ what the teacher can explicitly mediate (lessons can be organised around the identifying of these cues), and

+ what the children can learn to do in a reasoned, step-by-step way and later, automatically.

The following constructed example has <u>all</u> of these cues in it:

It was a very cold February evening, and Fiona had invited us to the student's hall for the *ceilidh;* it was her eighteenth birthday, and her parents had decided to celebrate. There was plenty of food and drink, which was just as well, because all the dancing made us very thirsty. (I might have chosen a dinner myself, it was so tiring!) But for Scottish people, coming together to listen and dance to music is a good way to celebrate.

So, what is a *ceilidh?*

As part of enterprise of constructing adaptive mediational operators, we need to know how books and teachers formally and informally engage in vocabulary instruction. And this is but one small part of language and literacy learning (cf. the English Language Skills Evaluation Final Report). What is attractive about such an analysis is that it would enable the mediator to work on vocabulary development as part of conceptual development.[3]

To try to put what we have said in this chapter in the context of the model we outlined at the end of Chapter Two will bring us to the end of this report.

The overarching paradigm we were working with is a developmental one which does not treat culture and cognition as separate entities; culture is not reified; rather, it is seen as a process. Education is not seen as a vehicle for the transmission of culture; rather, education is seen as a potentially enabling condition for intentional and meaningful action. Schooling would be seen as a social form, in which individual actors play out their individual roles, their available means for actions.

The teacher as actor is seen as a mediator who is both adapted to indigenous modes of being and adapting to new westernized modes of being. Both she and the learning tasks will mediate to the child, an adapting system. The reason why the teacher as actor acts as she does is circumscribed by social conditions. Black education as an adapting system will change in adapting to western forms of educations when genuine transaction between the systems take place; otherwise western forms of schooling may remain opaque to the adapting system. The adapting system is also likely to undergo transformation in this transaction.

We are interested in descriptions of processes and action but also with explanations about the possibilities of change. The mechanisms of change that have been identified are both extrinsic (in the Vygotskian paradigm) and intrinsic (in the Piagetian paradigm). These mechanisms of change operate at the "metasubjective" level of analysis proposed by

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[3] What is also exciting is that information of the type in cues 1-7 also occurs in the semantic specification of the lexical items in the lexicon. What the learner also has to develop is a specification of the grammatical characteristics of the item. Therein lies a very complex task analysis.

Pascuale-Leone. The other four levels - objective, phenomenological, subjective and ultrasubjective - are all accepted as legitimate and necessary levels of analysis for the overall task of formal schooling, and for the specific tasks that constitute it.

Change is seen as occurring in the Zone of Proximal Development: this zone can exist between adult and child, and between modes of transacting with the learner. The teacher may transform a task into a familiar form in which case genuine development will not occur; however, if the teacher can present a task in a conflicting way and provide the resources for the child to surmount the conflict, then development will occur. The modes of being and ordinary ways of doing tasks that the teacher brings to bear on a problem solving situation constitute the mediational operators which operate in the ZPD. The mediational operators themselves must be transformed in order for eductional change at the deep level to occur. Agencies of change for the teacher would be other "adapted" teachers, but the tasks themselves must mediate different ways of approaching problems. The model that we presented at Figure 2.8 (and which is reproduced below) is an attempt to integrate what we discussed about the difference between ideal and indigenous operators, and shows that transaction is needed between the two systems. (Circles 3 and 4 would require further research.)
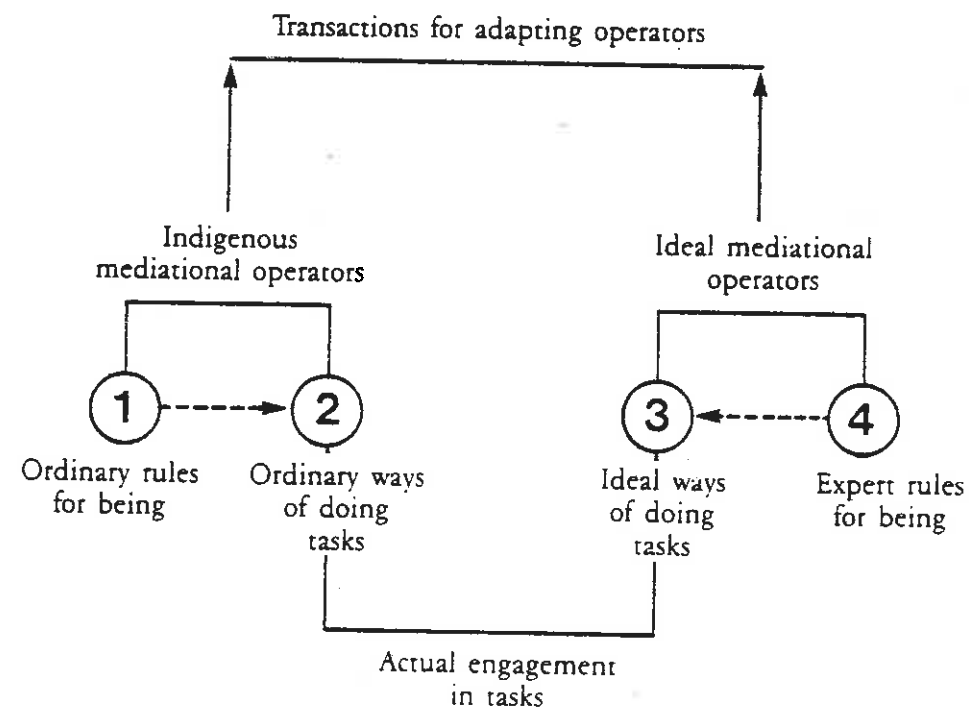

Figure 4.4 Changing the mediational operators in formal learning (adapted from Craig, 1985)

This model is a general one for "the task", and naturally the task of the child changes during the course of primary school, and in the course of learning a second language that is to become the medium of instruction. The task as it is conceived of in this paradigm does not simply consist of a description of the manifest performances constituting it; rather the underlying logic of the task is analysed, as well as the taken-for-granted aspects, which may only be discovered empirically. This is where the method of cross-cultural psychology can help in analysing tasks that are part of the everday curriculum. We also need to know what the learner brings to the task (and here we may discover what he does not take for granted). Finally, there is an intrinsic need for us to understand the nature of the cognitive- affective structures that the child brings to the task.

A central role in this model is accorded to the learning materials as change inducing agents: otherwise we are caught in the circularity of poor teachers teach poorly (through the medium of English, too), pupils who perform badly (through the medium of English, too), a new generation of poor teachers etc, etc. One may best promote genuine learning in a task domain where the rule systems are too complex to teach, by promoting *self-regulatory functions* that support rule acquisition by activity. These functions will be part of the learning resources that will mediate to teacher and pupil alike.

The paradigm that has been described here is derived in large part from the work of the Natal group of cross-cultural cognitive psychologists. To extend the metaphor of transaction further, real adaptation in curriculum research and development will occur when we bring these ideas into transaction with the more traditional notions of child-centredness which dominate much of current thinking in education. The work that began on the Threshold Project may find a legitimate extension in ongoing curriculum development.

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