ADULT NUMERACY,

MATHEMATICAL EDUCATION

AND

SOCIAL MEANINGS

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DECLARATION

I declare that this dissertation is my own unaided work. It is being submitted as part fulfilment for the degree of Master of Education in the Department of Adult Education, Faculty of Education of the University of Cape Town. It has not been submitted before for any degree or examination in any other university.

Signed by candidate Signature Removed

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CONTENTS

ABBREVIATIONS

ABE	Adult Basic Education
ANC	African National Congress
BNA	Basic Numeracy for Adults
Cosatu	Congress of South African Trade Unions
CNE	Christian National Education
CSIR	Council for Scientific and Industrial Research
CBNC	Constructivist Basic Numeracy Course
CED	Cape Education Department
DET	Department of Education and Training
ELP	English Literacy Project
ERS	Education Renewal Strategy
KMWTP	Kumon Maths Workplace Training Programmes
M&T	Mathematics & Technical Training Consultants
NLC	National Literacy Cooperation
NEPI	National Education Policy Investigation
NECC	National Education Coordinating Committee
NTB	National Training Board
NTS	National Training Strategy
NGO	Non-Governmental Organisation
NCTM	National Council of the Teachers of Mathematics
Prisec	Private Sector Education Council
TELL	Training in English Language & Literacy

CHAPTER 1

ADULT NUMERACY AS A DISCOURSE WITHIN A MATHEMATICAL EDUCATION

> *"You cannot say you are free to exercise your democratic rights if the social conditions make it impossible for you to eat, engage in political debate, find a job or house because you are illiterate."*
> (Ake, 1991:12)

The unbannings of February 2, 1990 have started the process of resolution in the political sphere and of the reconstruction of all aspects of social, political and economic life for the majority. The process of dismantling apartheid is finally on the agenda. Whilst any new government inherits the legacy of deprivation generated by apartheid and the mass aspirations articulated within the liberation movement, it also has to operate within a vastly changing world. Key aspects of these changes are equally located in the changing nature of work generated by changes in technology, as well as by changes in models of governance.

The current period of political transition is characterised by a range of contending proposals for the reconstruction of education. The politicised discourse of the policy proposals of the African National Congress (ANC), the Congress of South African Trade Unions (Cosatu) and the National Literacy Cooperation (NLC), which are dealt with in detail in the course of this study, refer to education as a deliberate force for civil redress and economic reconstruction. These specific proposals are equally concerned with the changing nature of civil and economic life, and about the nature of skills and attributes schooling graduates need to have achieved. This interest in educational outcomes, whilst tied to the economic imperative, is looking to provide different subject positions for the majority of citizens from those which have characterised the social fabric of the past.

Whilst the current inadequate schooling system has created a huge need for adult education programmes with a focus on literacy and numeracy, the field is characterised by

> *"little in the way of concrete proposals for the structuring of an adult literacy and basic education system..... At the same time, the importance of creating an effective system has been stressed by the democratic forces in South Africa, as one instrument for*

> *addressing the historical inequalities of the apartheid system, building the human resources potential of our society, and for political democratisation".*
>
> (NEPI ABE, 1992:52)

At the current conjuncture of a re-aligning set of social forces, a new and legitimate (adult) education system would need, in its reconstruction, to be such that its processes are based within a conceptual history of People's Education[1], developed during the education struggles of the 1980's, but also located within the current discourse of education - what Muller & Cloete (1990:3) have characterised as a shift from "a discourse of radical needs to a discourse of means."

The Research Question Elaborated

Besides this general context indicated by the moves to systematise adult basic education, the specific field of adult numeracy is itself characterised by sets of disjointed activities. This is marked by, on the one hand, a proliferation of literacy projects with an increased interest in numeracy, large industrial enterprises embarking on numeracy training programmes for their staff, and commercially produced and marketed packages of varying merit[2]. On the other hand, there is a dearth of systematic access to the theoretical resources available to adult numeracy. In many cases within numeracy programmes and packages, adult numeracy is taken to be an element of literacy. In other cases, it is treated as the technical manipulation of numerical symbols and which can most appropriately be referred to as arithmetic. Whilst both of these approaches develop certain computational and number reading skills, it is argued here that they do not develop the generic skills commonly associated with and expected from a mathematical education[3].

With the current historical conjuncture of social and political forces, adult numeracy would need to be "forged by a link between pedagogical prescription and political analysis" (Taylor, 1991:107). Precisely because of this social interest and political pressures for a mass literacy and numeracy (contextualised within a "people's education" which seeks to validate personal knowledge), this research study derives from a key debate in mathematics education which centres around whether mathematics is an enterprise of abstraction or with some `use-value'[4]. For the implications of this for adult numeracy, a systematic approach is needed.

Adult numeracy tends to be located at the "use" end of this continuum and has mostly been concerned about a number competence for use in life and work. This still remains practically important but the discourse of adult education referenced here is one of `a good general education'[5]. This suggests that the rather neglected `mathematical' end of the debate needs to be heard. The hearing it is offered here is highly distilled and can be encapsulated as follows. Mathematics education serves as induction to mathematics which has, or has not, to do with practically useful knowledge, like for example, the development of technology. An induction into mathematics might be, or only partially be, about developing rational and logical thinking within a neutral subject area which can serve as a general resource.

Whilst the major concern of this research study is to locate adult numeracy as a discourse within mathematics education, this study develops its framework by problematising both ends of the debate. It argues that an adult numeracy developed exclusively within either polarity of the traditional abstract-utilitarian debate is inadequate for the current social project which provides the educational context of an adult numeracy.

Firstly, the question of neutrality needs tackling. This brings into question how ideology and social interests have determined the nature of mathematics education as this underpins its aims, objectives, content, pedagogy, assessment forms and general outcomes of education. Some argument is presented from a socio-historical perspective of the selection of dominant mathematical knowledge. The implicit questions of power relations have then been addressed at two levels. The one is to locate interest groups ideologically, and the other is to engage with a textual analysis to look at how these power relations develop specific subject positions for learners and teachers (tutors) through the form and context of the numeracy texts.

Secondly, it is necessary to look at the ramifications of utilitarianism. It has been addressed here through an ethnomathematical[6] perspective. This looks at what people do so as to identify `everyday practices' which are seen to be mathematical, and mostly intended for developing less alienating school curricula. Despite the key developments in this area, a substantial critique emerges of the ethnomathematians as they reference these everyday practices to the formal body of mathematical knowledge[7]. The other critique comes from a cognitive approach which has shown how discursive resources[8] in numerical practice are harnessed differently within social and school situations.

Finally, although the possible elements of the mathematical construction of an adult numeracy education are not substantially developed within this research study, the theoretical resource of a textual deconstruction identifies the subject positions available to tutors and learners from the types of apprenticeships which numeracy materials suggest. As these materials have been developed under particular conditions, they would reflect the ideological interests of their producers. This final step of the research study is seen to be an important social elaboration "in the reconstitution of a different person" (Kibi, 1992:17).

The Research Design

With the research question having a social interest, an appropriate interrogation of adult numeracy would need to be woven from a number of threads. Firstly, it would need to be situated in the national education policy proposals of the ANC, the NLC and Cosatu. These proposals elaborate a counter-hegemonic discourse in education. Secondly, the primary source for developing this framework would need to be derived from empirical and theoretical sources within mathematics education. And lastly, it would need to broadly take account of the existing materials and experiences of numeracy projects and programmes.

The essence of the debate derived from a review of the literature in mathematics education, and as summarised above, is the requirement of numeracy materials and texts to meet the use criteria as well as those which develop a mathematical understanding. The objective of this review was to construct a framework for an analysis of a selection of numeracy materials. As this research study is situated in the national policy proposals for educational reconstruction, the analytical tools derived from the literature need to have a capacity for both micro and macro textual deconstruction.

At a political level, some pointers are indicated in the resolution of the education crisis broadly. In the ANC's draft education policy document, education reconstruction is approached by addressing the root causes of the crisis thus eschewing any "quick fix" approach. This needs to be understood in terms of the aspirations of the ANC's constituency which has, by and large, lost all belief in the current system - a system which has also given rise to the dismal narrative of illiteracy in our country. Further, The educational needs of the traditional support base of the ANC is arguably at the level of

adult basic education (ABE). The ANC maintains a particular interest in an adult education system which has the capacity to intervene positively in the situation of semi- and illiteracy.

Because of the constituencies of the NLC and Cosatu, their education proposals are focused almost exclusively on the educational needs of adults. These proposals enter a field where narrow vocational skills have been tightly determined by particular job categories and industries. Besides Cosatu's call for the restructuring of the entire provision of education to adults, it also brings a particular pressure to bear on numeracy education; a concern which emerges from the technological changes in industrial production.

The ANC and Cosatu, and to a lesser extent the NLC, explicitly state as a key goal for all sectors, a unified education system - it must provide a good general education which will develop citizenship in a way which is sensitive to the potential of the individual and which is linked to economic recovery. Further, key debates of concern are around questions of structuring and organisation, national standards, certification and curriculum articulation with the formal system.

In synopsis, a socially embedded adult numeracy cannot be based within either polarity of the utilitarian-abstract continuum. Rather, it needs to work across both.

Process of the Research Study

In sum, the theoretical framework proposed here for adult numeracy, and developed from a discourse of mathematics education, has as its task the elaboration of the social implications of principles in adult education and the pedagogic outcomes of three sets of numeracy materials.

Chapter 2 develops a theoretical framework of analysis for adult numeracy and derived primarily from a selection of available mathematics education literature. This draws on the socio-historical, ethnomathematical and cognitive discourses of mathematics education referred to above. The key concern of the analysis is to examine how the discursive resources of a mathematical education develop subject positions. This framework includes a location for a textual analysis.

The analysis of the ideological location of the education proposals of the ANC, Cosatu and NLC is tackled in chapter 3. This is focused by a concern for elaborating the type of adult numeracy which might emerge from their ideological position. A further concern is elaborated within some of the issues of a numeracy education as a basis for a "technological literacy".

Chapter 4 applies the analytical framework to three numeracy programmes. Specifically, the work of English Literacy Project (ELP), a literacy project based in Johannesburg and currently producing numeracy and life-skills booklets; Mathematics & Technical Training Consultants (M&T) which is a mathematics programme focusing on the needs of the workplace; and Kumon, a Japanese mathematics package currently available for learners in both formal and non-formal educational settings. Although there is some concern for ideologically locating the programmes, the major focus is to consider the assumptions which they make about the identity, the nature of interaction, and therefore about the subjectivities of the tutors and learners.

Besides the work of these programmes being fairly representative of the numeracy materials currently available, two of them, Kumon & M&T, were selected on the basis that they are making claims of locating adult numeracy within a mathematics education. This was seen to merge well with the concerns of this research study. As M&T's general approach is linked with the current work being undertaken in reconstructing the formal school curriculum, it might be bringing some advantage around the concern for articulation between non-formal adult numeracy and the formal schooling system[9].

Finally, each of these programmes made their materials available for inspection though in the case of M&T and Kumon, this was for a limited period and they were not on hand at the time of analysis. Other than Kumon, whose author is in Japan, I had the opportunity to interview each of the other course developers. I was, however, able to interview Kumon's representative in South Africa.

As this research report is largely concerned with applying a framework of analysis to existing numeracy programmes and projects, the last chapter looks at some implications for adult numeracy of applying such a set of analytical tools.

NOTES

1. For an elaboration see, for example, Glenda Kruss (1988) George Mashamba (1990)
2. The more established programmes of this range include: the Gold Fields Training Centre, Kumon, English Literacy Project (ELP), Training in English Language and Literacy (TELL), Constructivist Basic Numeracy Course (CBNC), Mathematics & Technical Training Consultants (M&T), Somerset House Adult outReach Education (SHARE), Project Literacy (Prolit), the South African Council for Higher Education (Sached), Using Written and Spoken English (USWE), the Adult Learning Project (ALP).
3. Whilst generic skills might be learnt within specific contexts (both mathematical and social), they are mostly generalisable so that they can be recontextualised within a variety of situations.
4. Mary Harris (1991) presents an account of how this debate has developed historically. She shows how workplace skills have influenced the formulation of school mathematics curricula.
5. Whilst education is linked to economic growth and reconstruction, Cosatu specifies that "courses should help develop understanding of subjects like mathematics", education should develop the capacity to be involved in political decision making, and to meet the educational needs of all South Africans (Cosatu ABE discussion document, undated).
6. This discourse is elaborated in chapter 2.
7. This concern is expressed by Dowling (1991:104) in that the "signification of these practices as mathematics remains with the researchers and not the practitioners".
8. These Foucault (1972:46) describes as the relations and rules made available by discourse itself. Discourse, in Foucault's sense, makes possible disciplines and institutions which in turn sustain and distribute these discourses. The rules of a particular discourse do not allow certain things to be said, instead imposing certain ways of looking at the world on participants whilst excluding alternatives.
9. M&T draws its socio-constructivist framework from the work of the Research Unit in Mathematics Education at the University of Stellenbosch (RUMEUS). This unit is researching an alternate formulation of the school mathematics curriculum.

CHAPTER 2

SUBJECTIVITIES WITHIN ADULT NUMERACY

This chapter sets out to develop the theoretical terms for a textual analysis on three sets of adult numeracy materials in chapter 4. The rationale of this analysis is located at three levels. Firstly, there is concern about the internal coherence of the materials' expressed goals as well as their capacity to meet these goals. Secondly, it is proposed that the concerns of adult numeracy can appropriately be located within the discourse of a mathematical education. Finally, these materials are focused against the emergent education proposals which deal with the restructuring of adult education and with particular reference to the type of mathematics education likely to be part of such a system.

The propositions developed here are concerned with an adult numeracy education which is an element of mathematics education. Within this, the particular focus is situated in one of the unresolved debates within mathematics concerning the usefulness of mathematics. Ernest (1988:99) distils the essence of this debate by highlighting the two essential approaches: the instrumentalist view which sees mathematics as "a set of unrelated but utilitarian rules and facts; [and] the Platonist view of mathematics as a static but unified body of certain knowledge". The concerns of this chapter are to do with a third less polarised category and which Ernest (1988:99) calls a cultural approach to the development of mathematical knowledge. This view relativises the development of mathematical knowledge by locating this process within political and social institutions.

This utilitarian-abstract dualism has impacted very directly on the content and process of mathematics education, and, it is argued here, on numeracy. Utilitarianism tends to be identified with context specific learning often found in literacy projects where numeracy is dealt with as a element of language and life-skills. Another form tends to deal with numeracy as a fairly technical process prioritising the memorisation of rules. This latter form is often called arithmetic. The danger of both is that they tend to be narrowly tied to specific outcomes.

The symbols and syntax of arithmetic are clearly derived from those of mathematics,

which then forms the elements of these intersecting sets. Some of the claims of mathematics is that it is abstract, neutral and generative so that the skills acquired within this discourse are applicable to other situations. The aim of this chapter is to use available theoretical tools to dispute the claim of neutrality and in so doing lay the basis for incorporating elements from the discipline of a mathematical education into a framework for adult numeracy.

This is done by firstly drawing on the social critiques of mathematics education and presenting here the case for it not being `neutral'. It then draws on recent developments within cognitive and ethnomathematical approaches which jointly serve to enrich the resource pool of what might be termed mathematical knowledge. The cognitive analysis however reveals empirical evidence disputing the assumption of mathematics' direct applicability from `everyday' practices to the development of formal mathematical or numeracy education texts. Both of these approaches serve to clarify the type of articulation which is appropriate for adult numeracy and which can be derived from learners' experience.

Finally, developing an understanding of what is practically useful knowledge on the one hand, and some dimensions of the discipline of mathematics on the other, serves as the basis for a framework of a textual analysis of numeracy learning materials.

1. Some Conceptions of Adult Numeracy

Besides the approach which links numeracy with the numerical component of literacy, it is possible to construct a "shopping list" of definitions for numeracy available within literacy projects - practical mathematics, mathematics in the real world, using numbers consciously within a context, and "numeracy as the capacity to use a calculator sensibly" (Girling, 1977). Specifically, TELL, a Johannesburg-based literacy project, summarises this approach by describing numeracy as "having mathematical knowledge, using numbers correctly when necessary, having the confidence to use one's number skills, understanding how numbers relate to social and political issues, questioning skills and critical thinking"[1].

Both commercially produced packages referred to in this research study discuss numeracy skills in a more "mathematical" language although it is still discussed within a framework of "useful" attributes. The Kumon package confines its content to the acquisition of the mathematical skills of formal schooling. These are seen to precede conceptual

development and application. M&T approaches numeracy from within a problem solving framework[2]. This is specified as those problems which carry the "germ of important mathematical ideas"[3] and whose content resonates with learners' lives. Basic numeracy is essentially learning about number concepts.

As there is a tacit underpinning of adult numeracy to the formal school content, a cursory examination of the new school syllabus (Cape Education Department, 1991)[4] reveals only limited reference to social context and mathematics' "utilitarian value". The more substantial approach discussed in the std 5 - 7 "new" school syllabus directs teachers to develop

> *"relational understanding (what to do and why) as well as operational understanding (what to do). Mathematics may be seen as a network of interrelated ideas which are derived from number and space and form a coherent structure".*
>
> (CED, 1991:2)

This syllabus, currently being introduced into white schools and being piloted in a selection of Department of Education and Training (DET) schools, highlights the need to develop a

> *"number sense [through] a thorough knowledge of basic addition and multiplication facts, techniques of mental arithmetic, pencil-and-paper methods for adding columns of figures, for subtraction, for multiplication and for division with understanding of the laws of arithmetic and place-value principles involved; and the ability to estimate".*
>
> (CED, 1991:3)

This syllabus is developed from a cognitive, and specifically constructivist[5] perspective. This resonates with some of the work undertaken on the psychological aspects of mathematical abilities of school children in the former USSR by V Krutetskii. He develops nine categories as the "basic characteristics of mathematical thought" (Krutetskii, 1976:87). These include the abilities to: formalise, generalise, operate with numerals and symbols, sequence, shorten the reasoning process, reverse a mental process, be flexible of thought, possess a type of memory for generalisations and formalisations, and work with spatial concepts (Krutetskii, 1976).

This referencing of adult numeracy to the formal system of school mathematics is not unproblematic as these curricula are themselves in a process of change. Besides the South African changes referred to above, the advent of the national curriculum in Britain has opened up old debates on the content and procedures of a national system. In Britain, there has over the years been an interest in an investigational and problem-solving approach[6] to teaching and learning mathematics. The impact of this on the curriculum is such that

> *"generalising, conjecturing, abstracting, symbolising, structuring and justifying, figure more prominently than the specification of mathematical content."*
>
> (Ernest, 1991:191)

The forms of investigations has now changed to ones which are more easily evaluated. A sustained critique of this curriculum belongs elsewhere[7] but a critique of an investigational approach notes that most investigational tasks in school texts are limited to activities which develop inductive reasoning whereas an apprenticeship to the discourse of a mathematical education requires the equal development of deductive procedures (Dowling, 1992). Therefore, even though learners might be thinking a lot more about mathematics than the more conventional pedagogies allow, they are, by and large, not invited into the domain of the pure mathematician.

A Social Perspective of Adult Numeracy

An approach to numeracy education which is embedded within specific contexts and referred to above can be juxtaposed against an explicitly social perspective. Jeff Evans, a statistician who has done work around the concept of the "barefoot statistician" (Evans, 1988) which he takes to mean community-based statistics workers, extracts three aspects of numerical development: confidence and competence with numbers, practical skills, and a critical appreciation of numerical information (Evans, 1989). He overtly highlights the social nature of this understanding and explores the consequences of innumeracy at a material and ideological level for both the individual and society as a whole.

This approach is developed further by Marilyn Frankenstein who has brought Giroux's concept of "educating for critical citizenship" (Frankenstein, 1989) into the teaching of numeracy. Her learners are non-traditional students - adults whom the schooling system

had not streamed for college - and she focuses her work on bringing an understanding to statistics which is embedded in the social. She emphasises a process approach, an integration of skills with context, and reflection. She develops the concept of a mathematical literacy and emphasises the

> *"basic concepts underlying the structure of the number system, the meaning of the various forms in which we express numerical relationships, and the additional meaning we can get from descriptive statistics by performing numerical operations."*
>
> (Frankenstein, 1992, draft research proposal)[8]

The linkages possible from this kind of conceptual base include a mathematics which is not rote learnt as discreet bits of knowledge but as a tool for understanding social, economic and political institutional structures and which locates numeracy within a socially empowering literacy. Further, it lays the basis for unravelling the content of a technological literacy[9] and for an engagement with the mathematical practices which persons engage with in their lives.

These types of "everyday" practices are seen as culturally determined and have been called an ethnomathematics. In an anthropological-type survey of a range of social activities, Alan Bishop (1988) has identified six mathematical activities in which, he argues, all societies engage. These he specifies as: counting, locating, measuring, designing, playing and explaining. This anthropological mathematics, an ethnomathematics, D'Ambrosio (1985) calls a matheracy. He depicts a mathematical literacy as being one which carries a cultural bias. He explains:

> *"Now we include as mathematics, apart from the platonic ciphering and arithmetic, mensuration and relations of planetary orbits, the capabilities of classifying, ordering, inferring and modelling. This is a very broad range of human activities which, throughout history, has been expropriated by the scholarly establishment, formalised and codified and incorporated into what we call academic mathematics but which remains alive in culturally identified groups and constitutes routines in their practices."*
>
> (D'Ambrosio, 1985:45)

In sum, although the production of "mathematical activities are the creation of

mathematicians" (Walkerdine, 1981:113), the contending roles which these activities play in cultural and social life suggests a more complex picture. What is being referred to here is a type of utilitarianism which often juxtaposes a basic skills approach against a conceptually elaborated approach of understanding (Walkerdine, 1981:22). Gee (1990:138) elaborates the limitations of a functional literacy and refers to it as "a concept which is squarely embedded in and the product of the `commodity myth' [and which] is conceptually incoherent". Beyond this, the essentially social approach of ethnomathematics, suggests that each activity implies "beliefs, values and attitudes" (Gee, 1990:140).

2. Socio-Historical Perspectives on the Development of Mathematical Knowledge

For mathematics educators who are concerned with the history of the development of mathematical knowledge, there is an understanding that both the mathematics offered in schools and the mathematics which confronts the ordinary citizen each reflect processes of the selection of knowledge. Both the conditions under which mathematics was developed and selected have been determined by particular social and economic conditions.

Developments in mathematics historiography have exposed a rich non-western contribution to mathematical knowledge. Broadly, two clear and distinct routes can be traced. The one originates amongst the middle Eastern and Asian peoples where mathematical knowledge developed within the needs of mercantile trade. The other comes from ancient Greece to which academic mathematics is mostly referenced[10]. From recent historical research[11], it is clear that the Greek tradition is constructed on the mathematics of Egyptians, middle Eastern and Asian peoples. Despite a common weakness of this historical route which tends to ignore the nature of some of these societies[12], the general contribution has extended the understanding of the development of mathematics. E Singh, for example, argues that the history of mathematics has been distorted so that black persons are invisible, that mathematical skills seem to bear no resemblance to the solution of real problems, and that it perpetuates social divisions. These are reinforced by a teaching methodology which devalues self-taught methods (E Singh, 1989:146).

At the level of an institutional analysis, Paul Ernest (1991) argues that the selection of content within a mathematics curriculum reflects choices based on the particular organisation of power relationships in society. He identifies three such interest groups: mathematicians, mathematics educators and groups inclusive of social and economic

interests. He draws on the work of Raymond Williams in teasing out these interest groups and referring specifically to "the industrial trainers, the old humanists and the public educators" whose aims and ideology determines their approach to education broadly, as well as to mathematics (Ernest, 1991).

These UK specific groups cannot be referenced directly to the South African situation. Least problematic would be the industrial trainers whose concerns are with "drill, rote learning and authoritarian discipline" (Ernest, 1990). The old humanists, concerned with pure mathematics and standards and which Williams is referencing in the UK, could be replaced by the conservative fundamental pedagogicians[13] in South Africa, presenting a dramatically different picture. The public educators can best be identified as those concerned with changing the form and content of mathematics so as to enable students to think and act critically in addressing society's problems. In South Africa, this group might have been chiefly located in small and marginal numbers at the traditionally English speaking universities.

Ernest extends these original groupings which were developed in the early 1960's, by categorising two further and recent groups: "technological pragmatists and progressive educators" (Ernest, 1990)[14]. The kinds of characteristics he attributes to the former echo much of the documentation currently emerging on competency based training in industry for adult basic education:

> *"pragmatic utilitarian tradition in education, which values practical skills, technological progress and the certification of learning, all as a means to furthering an economic conception of society, without the backwards looking view of the industrial trainers."*
>
> (Ernest, 1990)[15]

The progressive educators are those associated with learner-centredness, discovery learning and problem solving. Yet both of these, he argues, although progressive in different ways seem to ignore the need for social restructuring and focus exclusively on the educational needs of the individual, who is always constructed in opposition to the social. Finally, Ernest suggests that of these five groupings only the somewhat marginalized public educators seek social change.

Two British mathematics educators, John Abrahams and Neil Bibby (1988), depict two

types of situations where the outcome of this selection of mathematical knowledge plays a role within social environments and which affects ordinary citizens. The first type is where citizens are "confronted by official statistics, basic numeracy requirements for appraising salaries, wage agreements/negotiations, tax, etc." (ibid). The second type is where the context and process of mathematicians' work creates the systems which shape citizens' experiences.[16] Mathematicians are employed within governments, within the military, and within large business conglomerates, and within the industrial sector. A strong case for the political consequences of mathematicians' work is presented in the following way:

> *"to base a perspective on the notion that mathematics is intrinsically good, and then to deny responsibility if its outcomes should be bad, through the negative impact on the lives of others in society or school, is morally irresponsible and incorrect."*
>
> (Ernest, 1991:179)

Mathematicians are then the "producers of organised knowledge which can become the everyday experiences of others" (Abrahams & Bibby, 1988). They produce within society where power, conflicts and contradictions are reflected. As one possible element of the work of mathematicians, Skovsmose (1989:30) highlights how social interests influence the development of mathematical models so that "a model is not a model of `reality' as such, but a model of a (conceptual) system, created by a specific interpretation".

Yet, ordinary citizens are confronted by the product of this mathematical activity. To be able to operate within these systems, they need certain numerical competencies which may be seen as narrowly functional or critical. Apple & Christian-Smith (1991:7) phrase their description of this continuum in the following way:

> *"teaching the `masses' to read ... enables a `civilising' process, in which dominated groups would be made more moral, more obedient, more influenced by `real culture'. And for others, such literacy could bring social transformation in its wake. It could lead to a `critical literacy', one that would be part of larger movements for a more democratic culture, economy, and polity."*

The process of selection for the development of number-based social systems and school curricula is informed by power relations in society. These in turn affect (non-numerate) citizens' ability for social participation. What is of concern here is what sort of numerical capacities ordinary citizens would need so as to be able to engage with and change the

nature of this selection to social systems whilst bearing in mind that some of these issues might be more moral and political than numerical.

This brief overview of possible interest groups involved in the process of selection of mathematical knowledge lays the basis for socially locating the documents under review.

3. A Cognitive Perspective

A second group of mathematics educators, whose work links with the issues raised above, have been concerned with the numerical practices of ordinary citizens and have begun their investigations by examining the way people use numbers in their day-to-day lives. This route, broadly characterised as neo-Vygotskian[17], has generated two types of aims. One aim is to expose how numerical operations and reasoning are learnt and used. Their concern has been with questions of cognition and learning transfer. The other has been to assist in deriving familiar contexts and content to assist the development of both formal curricula and work-related numeracy programmes.

This broadly ethnomathematical methodology has in many ways expanded the resource base of mathematical knowledge. Further, in its historico-cultural focus, ethnomathematics seeks to play a role in the de-colonisation process of countries like, for example, Mozambique through the work generated by Paulus Gerdes[18]. Taylor (1990) expands this and refers to this type of work as a "strategy aimed at stimulating a cultural rebirth amongst Mozambicans, facilitating the procedure of abstracting from familiar practical situations, and applying learned procedures to novel situations". U D'Ambrosio (1991:22) provides the following definition of ethnomathematics and its role in contemporary mathematics research:

> *"Together with the social history of mathematics, which aims at understanding the mutual influence of socio-cultural, economic and political factors in the development of mathematics, anthropological mathematics, if we may coin a name for this speciality, is a topic which we believe constitutes an essential research theme in Third World countries, not as a mere academic exercise, as it now draws interest in the developed countries, but as the underlying ground upon which we can develop curriculum in a relevant way."*

This general approach is reflected in studies conducted by Carraher et al (1988) with, for example, Brazilian street children in their commercial transactions, and sugar cane farmers in the trading linked to their agricultural production[19]. Another form of this approach is the "mathematics in work" research conducted in Britain[20] with the objective of informing the school curriculum from mathematical practices[21] found in the workplace. Jean Lave's more directly cognitive approach, has been to examine if and how formally learnt skills and techniques inform every-day practices.

In my view, the cluster of developments within this approach warrants serious attention for its capacity to impact on mathematics education. In this light, there is a set of very important and challenging critiques which have emerged from the work of Lave (1988) and Carraher (1985). Lave (1988) has found that people use "different discursive practices"[22] in formal and informal situations based in number work. Her extensive research around the shopping practices of adults with varying degrees of education shows, most commonly, that shoppers' coping strategies did not depend on their level of precise number work. Rather, that shoppers used a variety of strategies depending more on the social situation and the choices it offered. What may then be emerging from this research is that both the contextual and number based theme teaching which has commonly framed adult numeracy curricula might need to be revisited with a fresh eye.

Carraher's (1988) empirical research of in- and out-of-school arithmetic practices generally concludes that "despite the similarities in underlying principles, there are also striking differences in the conditions of practice" (Carraher, 1988:185) in these two types of situations. The research suggests that "when school algorithms are taught and carried out, the emphasis falls upon the rules, and hardly ever upon meaning" (Carraher, 1988:185). This suggests that despite the similarity of problem-solving procedures of these situations, learners perceive that it is not the same mathematics. From the viewpoint of teachers and those who construct the learning environment, Walkerdine (1981:141) points out that there are "huge differences between practices which utilise certain mathematical terms and principles and the practice of actually doing mathematics". She names the distinction between these two types of tasks as one which is instrumental to the completion of a related task and one which is purely pedagogic: "this requires a shift in the relations of signification[23] involved in the transition from one discursive practice into another" (Walkerdine, 1988:94).

The implications of this research for the development of learning materials needs closer

examination as this now begins to refer to what has been characterised as differing "subjectivities that are perpetuated by discourses through knowledge, disciplines, and in general, through textual attitudes" (Kibi, 1992:20)[24]. How discursive resources regulate social relations so that particular subject positions are formed within the teaching and learning of literacy practices is formulated by Gee (1991:145) as follows:

> *"[W]hat counts as an `individual' is differentially defined in different discourses within a single society and across different cultures. The various discourses which constitute each of us as persons (subjects) are changing and often are not fully consistent with each other; there is often conflict and tensions between the values, beliefs, attitudes, interactional styles, uses of language and ways of being in the world which two or more discourses represent. There is no real sense in which we humans are consistent or well integrated creatures from a cognitive or social viewpoint."*

The concern for what discursive resources are available for an examination of numeracy texts is developed in the next section. What has been suggested here, is that the various uses, frames and terms of numeracy are not necessarily best described by referencing a formal mathematics. Rather, that the types of numerical practices developed within the different discourses seek to provide particular subject positions for the learners.

In sum, this section has looked at developments in the relationship of "people's everyday practices" to the learning and teaching of mathematics. This has been approached firstly from an ethnomathematical perspective. A problem which is highlighted in an ethnomathematical approach is that it looks to validate what people do with number-work in terms of formal mathematics content. The more explicitly cognitive perspective included here points to substantial research which questions the assumption that developing learning materials derived from people's everyday experiences facilitates for learners to be apprenticed to a discourse of mathematics.

Deriving Tools for a Textual Analysis

In a vein reminiscent of Ernest's interest groups described above, Apple & Christian-Smith (1991:1) refer to formal school

> *"texts [as] not simply `delivery systems' of `facts'. They are at*

> *once the results of political, economic, and cultural activities, battles and compromises. They are conceived, designed and authored by real people with real interests."*

Texts serve as embodiments of what can be considered to be legitimate knowledge. Whilst a textual deconstruction reveals how society's stratification of race, class, gender, and regional biases are embodied within text, the task of this section is to draw together a set of analytical tools which can be used to identify how differing assumptions about the identity and subjectivities of learners and tutors are made and perpetuated in particular numeracy texts.

A converse approach to this debate, and from the perspective of a concern with the varying subject positions available for engagement with social functions, is that of Dowling (1991) who develops a matrix which he calls the "social structuring of mathematics". This structure locates how persons in social or work situations use the variously acquired resources at their disposal to deal with these situations:

> *"[A]n alternative view in which the contexts for mathematical activity are mapped out according to the social organisation of the various sites in which it may be said to take place....so that this mathematical activity must be consistent with the social organisation of its site of elaboration."*
>
> (Dowling, 1991:94)

At one level, as referred to above, learning materials "define the symbolic representation of the world and of society [onto which] subjective interpretations of reality and value judgements are projected as fact" (Sleeter & Grant, 1991:79). At this level, a textual analysis reveals the social bias which is embedded within materials. At another level is the linked construct of the way materials apprentice learners to the specific discourses inherent to a subject discipline.

This dualism has been described by Walkerdine (1981:22) along a propositional-procedural continuum which is of a similar nature to the psychological terms of "relational and instrumental understanding"[25]. Gee (1991:146) who is concerned with critical linguistics[26], makes the distinction by talking of "learning" in juxtaposition with "acquiring". Dowling (1992:20) refers to it as "epistemologically and procedurally elaborated text". Although each is bringing a slightly different element to this debate,

which will be elaborated below, what is of concern here is how numeracy materials apprentice learners into school mathematics and position them somewhere along the continuum been suggested by Walkerdine, Gee and Dowling.

Walkerdine (1981:22) describes the differences between propositional and procedural knowledge in the following way:

> *"...two qualitatively different kinds of knowledge and thinking. This distinction is a recognition of the fact that when people wish to complete some practical task successfully they may do so simply by following rules: by applying a procedure. But people may accomplish tasks by rule-following and still have little idea of why the rules are effective, or their range of applications. On the other hand, people may apply a procedure and at the same time know the rationale for the procedure, they may have a deeper understanding of the meaning of what they are doing and why the procedure works".*

This latter form of propositional knowledge, she argues, is what is of interest to the work of mathematics educators.

Acquisition and learning, locate different sources of power which are grounded in different forms of knowledge. Acquisition is a "good for performance" (Gee, 1991:146) knowledge base and is linked to the primary discourses which informally and unconsciously develop outlooks and approaches. Learning, on the other hand, is "good for meta-knowledge .... which often goes under the name of critical thinking" (Gee, 1991:147). This is a conscious and analytical way of gaining knowledge (teaching, for example) and is potentially vested with more power as it can engage with the dominant social discourses of legitimate knowledge. Following this approach, a "liberating" numeracy (literacy) needs to be critical and reflexive and is to do with meta-knowledge.

Dowling has extended his work on the social structuring of mathematics (Dowling, 1991) referred to earlier by elaborating a "language of description" (Dowling, 1992). This framework also extends the work of Walkerdine (1981 & 1988), working at the level of classroom teaching and learning interactions, and Gee (1991) who is concerned with how discourses shape literacy development. It is within this framework of four social domains (Dowling, 1992) - the esoteric, public, mythical and metaphorical - that epistemologically and procedurally elaborated texts[27] are located. (See Appendix A for the `arrangement'

and tasks of these domains.) Briefly, and to be elaborated below, epistemologically elaborated messages are mostly located within the esoteric domain and potentially develop generic skills applicable to a variety of situations. Procedurally elaborated messages are most commonly located in the public domain where messages are delimited to specific situations.

Two levels of motivation for this social framework can be established. The first is its claim "which will enable the movement between macro and micro levels of analysis" (Dowling, 1992:1). For example, between education policy documents and numeracy texts. Yet, this framework is not centrally about showing the correspondence of social biases reflected within learning materials at the ideological level. It is more concerned about the discursive resources for mathematics education available from the social domains referred to above. This now gives rise to the second concern located within the debate referred to earlier and which centres around useful or abstract[28] mathematical knowledge. Dowling (1992:2) suggests that there is a generally agreed on body of knowledge called mathematical knowledge which relates to "mathematical topics: arithmetic, trigonometry, set theory, calculus, etc. We can think of practices which are confined to this content as constituting a central body of specialism, the esoteric domain of school mathematics." On the other hand, he notes that most school texts currently include "applied or practical mathematics which concerns matters of more public familiarity" (ibid). This he calls the "public domain of mathematical practice" (ibid) and which he suggests is not mathematics at all.

His concern, as a mathematics educator, is with the discursive resources available in the esoteric domain as the signifier[29] for mathematics education. All "pure" subject areas signify from the esoteric domain. At the other end is the public domain which signifies "useful" activities (like shopping, catching the train) as part of social life. Brown & Dowling (1990) argue elsewhere for a different type of utilitarianism[30]. This can partly be understood as political protest against the "back-to-basics" characterised as the moves of the New Right, but also as a rejection of the subject positions which this discourse of mathematics education provides. Dowling (1992) argues, similarly to Walkerdine (1988), that materials located within the public domain fail by not apprenticing learners into the discourse of mathematics.

Besides the esoteric and public domain, Dowling identifies two further domains - the metaphoric and the mythical. Teaching-as-metaphor is mostly linked to particular teaching tools which illustrate a procedure or concept. It recontextualises into the esoteric domain

through the use of metaphors. In an example from numeracy materials elaborated in chapter 4, the use of a "fraction wall" to teach fractions shows how meaning is assigned from the metaphoric domain. Lastly, mathematics education is often located in the mythical domain where signification serves to validate moves which might be seen as mystification[31]. An example of this is the status given to statistical information when used within social and political settings. Walkerdine (1988:119) unpacks the process of re-locating mathematical significations in the following way:

> *"significations from a non-mathematical practice become transformed and rearticulated within mathematical discourse. This is not so much a case of the disembedding of a skill, but the prising apart of relations of signification and rearticulating them to produce new signs."*

The apprenticeship in the field of mathematics education and numeracy in particular suggests that the materials and pedagogy need to be based on an epistemology concerned with propositional knowledge rather than procedural knowledge. This runs counter to approaches which teach algorithms and operational procedures without developing the capacity to recontextualize these to other situations.

In sum, this section has shown that adult numeracy materials which develop generic skills need to be based on an epistemology which enables this process. Dowling provides a framework of social domains for analysing the capacity of practices and materials to do this. He shows the importance for materials which are publicly referenced, to have a sound grounding within the esoteric domain. This framework can also be used to detect moves in numeracy where certain claims are made but which are not reasonably grounded within the discipline.

4. Summary

Although it can be argued for that numeracy to be elaborated as part of different frameworks, for example as part of arithmetic or as part of a functional literacy, the perspective being developed here is that of numeracy as part of a mathematical education. Despite numeracy's relatively low status within the spectrum of mathematical practices, its location as a mathematical practice provides a platform for enhancing its educational potential.

The genealogical overview in this chapter has shown that the development of mathematical knowledge has not been a process of discovery of neutral facts, but rather that dominant social interests have actively constructed mathematical texts in a manner which serves their ideological positions. This account has needed to be extended into an analysis of the various subject positions which emerge from such texts.

The ethnomathematical account has gone some way in retrieving some of the "discarded" mathematical practices within the broader project of decolonization. It has also developed a methodology for examining the numerical components of everyday practices. However, once these practices are examined through the lens of a mathematical education, it becomes clear that they evidence a low capacity for relocation into the dominant discourse (esoteric domain) of formal mathematics.

The final section, whilst building on the developments reflected above, develops the analytical tools for locating mathematical practices within four domains, only one of which is the "pure" mathematical. Only numeracy activities which apprentice learners to the dominant subject positions within mathematics education, might provide the mechanisms for such shifts between subjectivities.

NOTES

1. Personal communication, Shelly Tracey, TELL's numeracy course developer, 1991.
2. This pedagogical approach is derived from a constructivist framework and is elaborated in chapter 4.
3. Personal communication, Piet Human, Rumeus, April 1992.
4. This is being developed from the Research Unit in Mathematics Education at the University of Stellenbosch (RUMEUS).
5. Constructism refers to the work initially of Piaget, Vygotsky (see later in this chapter), and to its recent elaboration by von Glaserfeld and is developed in chapters 3 and 4.
6. Although both of these approaches have often been taken as counter-hegomonic mathematical education practices, Walkerdine (1988) systematically elaborates that this is mostly not the case.
7. See, for example, Dowling & Noss, 1991.
8. Frankenstein has submitted this draft research proposal to the NECC Mathematics Commission, Western Cape, to explore the possibilities of collaborative work.
9. This term is used here within a similar framework developed as a social literacy and is taken to highlight the social nature of technology.
10. G Joseph (1984a, 1984b, 1985 and 1987) presents the most interesting analysis into the history of the construction of a Eurocentric mathematics.
11. See for example, M Bernal (1987)
12. Some concern is being expressed here on the as yet unproblematised approach to, for example, the marginalized position of women, and the slave-based production of many of these societies.
13. Fundamental pedagogics being the philosophical basis of Christian National Education.
14. Whilst these are useful categories for an initial analysis, in reality, texts often straddle a number of them. This limitation is illustrated in the next chapter when attempting to apply these categories to the education proposal of the ANC in particular.
15. Ernest (1990) is found in the unnumbered pages of the conference proceedings of the Political Dimensions of Mathematics Education.
16. These might be referred to as neutral "disembedded expert systems" (Giddens, 1990:21,22).
17. Derived from the work of Lev Vygotsky. He extends the work of Piaget by developing the social base of the learning and acquisition of knowledge.

18. For example, Gerdes' work has entailed the documenting of cultural practices which is intended to form the basis of developing post-colonial mathematics education curricula. In most cases, this is not `new' or different to Western mathematics.
19. D Carraher (1991:169) reviews three studies conducted in Brazil of "informally learned mathematics".
20. This Maths in Work project, coordinated by Mary Harris, operated from 1981 to 1991. Harris (1991) reflects a selection of the work undertaken in this project.
21. Strasser et al (1991:166) examine how the visibility/invisibility of mathematics in vocational practices affect pedagogic possibilities.
22. These are described as the relationships involved in the production of the discourse.
23. In the production of meaning, the signifier and signified can combine to produce a wide range of signs. These are delimited firstly by the boundaries of the discipline, by the intention of the `authority', and by the resources which each individual brings to the situation.
24. This is elaborated by Kibi (1992:18).
25. See Skemp (1976) for elaboration.
26. This is somewhat distinct from socio-linguistics which recognises the social construction of meaning but does not necessarily concern itself with the construction of the social.
27. In this study, text refers merely to the materials and documents of the projects under review.
28. A key element which extends this debate is focused on **when** theoretical developments in mathematical research become useful. In fact, most research results do appear to have an application but mostly after an extended period of time.
29. This relationship of the development of signs is developed by Walkerdine (1981).
30. Useful mathematics might be enacted within project based teaching, and what Brown and Dowling (1990) call research-based teaching.
31. Frankenstein & Evans demystify primarily the social use of statistics not the genealogy of the statistics itself.

CHAPTER 3

RHETORIC AND THE COST OF CRITIQUE

Chisholm (1992:149), referring to Ball's curriculum work in the UK, notes how

> *"struggles over school knowledge are shaped by a range of political, industrial and bureaucratic interests, each articulating different educational ideologies. Policy formation .... is the outcome of various complex struggles occurring at different levels: the economic, political and ideological, none of these being reducible to one another".*

This study is now to look at some specific political and ideological interests which are currently generating education proposals: the ANC, Cosatu and the NLC. It is concerned with developing a non-reductionist account of a socially oriented numeracy.

One of the concerns of this research study is to formulate a consistent analytical framework for numeracy materials which would have a number of tasks. Firstly, this framework needs to show how the content and organisation of the materials are consistent with the educational goals of the course developers. Besides identifying the nature of the consistency, what is further required from the framework is a capacity for identifying the nature of articulation between the implicit goals of the numeracy materials on the one hand and the broader goals of a restructured education system on the other. In other words, the social imperatives of education would be the external referent to the numeracy materials.

In chapter 2, a framework for numeracy was developed which identified it as a discourse of mathematics education. It was further shown that specific formulations of mathematics education reflect contending ideological interests which are implicated in the structuring of subjectvities in terms of particular hierarchies. This social construction of a numeracy discourse, which is contextually embedded and politically interested, is the essence of the framework to be used in discussing the ideological location of the education proposals of the ANC, Cosatu and the NLC. This location is further used as an indicator of possible formulations of a numeracy education.

The education policy proposals of these three groups each privilege a different type of education. Cosatu and the ANC frame their concerns in the language of "participation in

educational decision-making, and redress of historical imbalances" (NEPI, Curriculum Report, 1992:30). This inserts their broader principles of democracy and access into the education debate. A further thrust which emerges is a consistent reference to the need for economic development premised on an expansion of access to the natural sciences, mathematics and technology. These two imperatives might be elaborated as contradictory options. The NLC organisations have mostly been involved with small-scale literacy provision. Although they do not have the capacity for macro-policy formulation, there is a concern for their participation in policy development as they often represent "groups of people that might be neglected by others in their planning and policy development, such as rural learners, women, the unemployed and the homeless" (NEPI ABE,1992:58).

As there exists no coherent adult basic education system currently and besides concerns for the "social cost"[1] of innumeracy (illiteracy), all policy proposals are concerned with the scale of provision which might be required. There are however, no precise figures available on the number of innumerate persons outside of the schooling system and most recent documents refer to the 1991 census, generally taken to be a fairly unreliable measure. NEPI ABE (1992:5) puts the figure at 15 million, about 47% of the total population, with about one third of these people having had some schooling. A more useful breakdown indicates that 45% of black adults are illiterate whereas a further 25% are semi-literate (New Nation, 1993:15). Literacy, by definition, includes reading and writing of the quantitative dimension of number. Hence, I feel that it is safe to scale innumeracy at least alongside that of illiteracy.

A further problem is indicated by the NEPI Adult Basic Education report (1992:5) in that this measure is not sensitive "to the complexities of ranges and varying types of literacy". This becomes pertinent within a social framework of "multiple literacies/numeracies". As discussed in the previous chapter, the power of hegemonic groupings in society determine what knowledge becomes privileged and dominant, which skills are portable and marketable. Aronowitz and Giroux (1991:236) speak about this relationship in the following way:

> *"To acknowledge different forms of literacy is not to suggest that they should all be given equal weight. On the contrary, it is to argue that their differences are to be weighed against the capacity they have for enabling people to locate themselves in their own histories while simultaneously establishing the conditions for them to function as part of a wider democratic*

> *culture. This represents a form of literacy that is not merely epistemological but also deeply political and eminently pedagogical. It is political because literacy represents a set of practices that can provide the conditions through which people can be empowered or disempowered. It is pedagogical because literacy always involves social relations in which learning takes place; power legitimates a particular view of the world, and privilege legitimates a specific rendering of knowledge".*

However, it is within the broader project of changing the power relations of pedagogic determinants that quantification becomes important.

The approach followed here is to deal separately with political organisations (ANC & the state), industrially based programmes (Cosatu and a reference to management developed programmes) and NGO proposals (NLC). The state's and the management's proposals are only given some inclusion at the level of an overview to their ideological position so as to inform the likely compromises within the broader political context of a negotiated settlement. The major focus is on the ANC, Cosatu and the NLC which in terms of a discussion on a socialised conception of numeracy, share a reasonable amount of broad agreement.

Political Organisations

The ANC's education proposals are embedded within its broader interests as a political player and these reflect the popular aspirations of its constituency. Historically, the ANC has been steeped in a tradition which has articulated somewhat unproblematically the social and economic benefits which are derived from education[2]. Currently, the concerns of its constituency are evident within the ANC's general approach which prioritises issues of redress and development. At the same time, the world of governance which the ANC "inherits" militates against substantive restructuring of social and political institutions. The new state will carry much of the old with it within the constraints of the current economic climate.

This section will also look briefly at the state's initiatives in adult education with particular concern for the interests which it represents. This has become important if educational issues generally are to be addressed through negotiations amongst the key actors.

1. The African National Congress (ANC)

The ANC, a key national liberation movement contending for political power, frames its draft Education Policy (May & Sept, 1992) within a political agenda which is explicitly concerned with political redress, and economic development and redistribution. Throughout its documentation, it links the role that education plays in developing the democratic capacity of citizens with developing the "process of wealth creation and economic development" (ANC, Sept 1992:1). Further, it premises any restructuring of the education system within the broader ideals of the organisation which are articulated as the social "goals of democracy, equality, liberty and justice within a non-racial and non-sexist framework" (ANC, Sept 1992:1).

It draws from the international experience which notes that education cannot, on its own, be the "crucial independent variable in the transfer of resources to the poorest .... the educational space is also a symbolic one, at its heart concerned with change and development" (Chisholm, 1992:154). The ANC's proposal reflects an urgency for change by noting on the one hand an economy which cannot absorb job seekers, and an education system which has on the other hand "destroyed the culture of learning ...thus a whole generation of our youth have grown up believing that education and learning have no value" (ANC, Sept 1992:2). This tension between development needs and equity, between political legitimacy and the imperatives of capitalist accumulation place the ANC in a difficult position. Within an essentially socially transformative starting point however, some key issues in its education restructuring proposal relevant to the present discussion include:

- the principle of democracy is to be reflected in the administration, management and policy development of a unified national education and training system. Although the state is to be centrally responsible for the provision of all levels of formal and non-formal education, it is to work alongside the private sector, non-governmental organisations and community-based structures. Specifically, adult basic education is to be provided for an equivalency of 10 years of formal schooling;

- there is to be a national core curriculum based on the curriculum principles of "co-operation, critical thinking and social responsibility" (ANC, Sept 1992:6);

- the curriculum is to be framed within the ideal of a general education which explicitly links academic and vocational skills. This is motivated from both its anti-elitist democratic principle, and from the perceived imperatives of a changing modern economy;

- the system is to be modularised so as to allow greater mobility between all forms of education;

- the system is to be nationally accredited with a capacity to recognise "prior learning and experience" (ANC, Sept 1992:7).

The ANC's Science & Technology Policy Guidelines (ANC, May 1992:58), whilst similarly arguing for a type of social restructuring which eliminates gender, rural, disabled and age discriminations, makes the addition that science, mathematics and technology programmes are to be available at all levels of a general education and specifically within adult and worker education and training programmes. The emphasis placed on a mathematics education is also explicitly stated in the proposed policies of the Education, Training and Science Development, and the Development of Human Resources sections of its policy guidelines (ANC, May 1992).

The ANC approach to redress, democratisation and economic development appears to link human resource development, education, training, science and technology. This general approach is reflected within the CSIR's comparative study (Garrett & Clark, 1992) which identified several key elements for economic growth in newly industrialised countries, noting specifically that:

> *"heavy investment in general education and in vocational training is a characteristic shared by all the `success story' countries. They recognise that the skills of their people are the fundamental resource, and that literacy and numeracy are prerequisites for these skills to be developed."*
>
> (Garrett & Clark, 1992:18)

These types of shifts, although not stated specifically, are referenced by Mathews et al (1988:502) as

> *"a new industrial system (is being born) - based on the*

> *technologies of microelectronics and new materials, intelligent production, human-centred work organisation, worker responsibility and multi-skilling".*

Besides questions of organisation, accreditation and portability implied in this characterisation of the work-place, the impact on the curriculum points to:

> *"a broad base of knowledge and the requisite intellectual skills ....the development of resourcefulness, cooperativeness, independence and problem-solving abilities, as well as on literacy, numeracy and basic technical skills."*
>
> (Mathews et al, 1988:503)

In looking to locate the ANC's education interest ideologically, the range of its complexity emerges. Three different strands can be identified within the educational discourse employed by the ANC. The one is a liberal political discourse of "social justice, equality, social awareness" (ANC, May 1992) reflected throughout its policy documentation[3] and which links up to the public educator as developed and described by Ernest (1991:199): "this ideology is socially oriented, with its epistemology based on social construction, and its ethics based on social justice". Further, the public educator's theory of learning, as with the ANC's curriculum guidelines, stress "questioning and decision making" (Ernest, 1991:139) skills. Ernest (1991:199) goes on to say: "since [the public educator's discourse] is relativistic, in all domains it acknowledges the validity of alternative perspectives". Even though Ernests' categories reflect a selective process which cannot exist other than as analytical units, it is problematic in terms of the ANC's social base to locate its educational proposals as public educator.

A second discursive resource in education available to the ANC is the populist, anti-elitist strand of a "people's education/mathematics", a broadly socially constructed mathematics; what Ernest has categorised as the progressive educator. The implications for mathematics education in both these discursive resources is that the content and process becomes socially and culturally embedded, described broadly as an ethnomathematical[4] approach and referred to in the previous chapter. This categorisation generally, and the implications for a mathematics education, cannot be considered appropriate for its lack of pragmatic and economic concern at both a political and pedagogic level.

Finally, the third resource available to the ANC tends towards a socialist discourse of education, a utilitarianism which is relocated within the drive for social redress and economic development. This is further reflected in the ANC's concern for accreditation, and its concern with academic skills which have applicational value. This discourse might reflect a pragmatic counter to the New Right trend in education internationally and equally be legitimate in terms of the changing nature of work within a restructuring economy.

These sometimes contradictory discourses create ambivalences when "translating" the policy guidelines to frameworks for a numeracy education. The concerns for redress suggest strongly that the discourse of a mathematical education is a key element of a numeracy education curriculum. The ANC's emerging policy statements, which attempt to harness the political with the pedagogic, take on the more pragmatic discourse of the technological pragmatists. A key aim for mathematics education articulated here is "to further technology by thorough technological training [with school mathematics encompassing] pure mathematical skills, procedures, facts and knowledge...which are tools to be mastered [along with the] applications and uses of mathematics". (Ernest, 1991:162) It seems that the tension of the ANC position is running its social goals with the more strategic approach of the technological pragmatist.

2. The state.

The most unambivalent location of the state's ideological position, as reflected in the ERS (1991)[5] document, the National Training Strategy (NTS) document though emerging primarily from the business sector and referred to below, and the history of CNE, is within the ideological position of the industrial trainer. The educational aims still distinguish education "for the masses.... and for the higher social strata" (Ernest, 1991:147) with teaching based on principles of "the transmission of knowledge as a stream of facts, to be learned and applied" (Ernest, 1991:148). Further, the industrial trainer's location references no need for the re-structuring of social institutions. This approach is consistent with the state's approach of amelioration without historical imbalances being referenced as points of concern[6].

The most significant statement from the ERS (1991) proposals is the state's concern for certification of non-formal education. It recommends the setting up of a task team "of persons at the highest level of expertise from the public sector and the broad employer and

labour sectors .... to establish criteria for standards of competence as it relates to the requirements of the employer sector" (ERS, 1991: recommendation no. 3.11). Although this resonates with the Cosatu proposal discussed below in that it recommends a systematisation of non-formal education, the emphasis is on a type of vocational training which is based on a narrow conception of standards and competencies required within employment. In this approach, it privileges the employer sector with control of such a system.

However, as evidenced within the state's own concern for economic development, the industrial trainers' limited aims for mathematics education might be shown to be counter-productive:

> *"functional numeracy combined with low life-expectations fail to meet the needs for an ever increasingly skilled work-force, as expressed by employers. Basic mathematical skills are insufficient, and docility and lack of initiative are counter-productive in many, if not most, sectors of employment."*
>
> (Ernest, 1991:151)

The state's approach to non-formal education is likely to come under pressure as the nature of industrial production changes in response to developments in technology. The research of the CSIR (1992) referred to above, further provides evidence of the type of workplace numeracy appropriate for development. These might mark a shift towards the position of the technological pragmatist, not necessarily an unacceptable position for the state. The perspective of this group largely ignores the social and limits society's thrust for change.

Industrially Based Proposals

Educational issues of debate in the industrial sector tend to be tightly linked to expanding and re-defining vocational education and training. Employer-run programmes tend to be focused on the specific skills training needed by the job grades of each industry. This type of training has been characterised as developing an extremely limited training base which does not carry accreditation beyond its specific site of elaboration. Cosatu, on the other hand, is developing an adult education approach which is embedded in its political principles and which sets out to challenge what it identifies as a narrow vocationalist

approach. The primary focus of this section is to look at these work-place proposals with special emphasis on Cosatu.

1. Congress of South African Trade Unions (Cosatu)

COSATU's education proposals are contained within its broader Human Resources Project and is best understood in terms of its constituency: employed and recently retrenched industrial workers. This constituency can be characterised as those who do not have a standard 7 school certificate which serves as the entry requirement to technical colleges. Often, these workers do the work above their waged and employed grades with informally acquired, but unrecognised, skills. Increasingly, the impact of electronic technology is changing the nature of work to what is described as a post-Fordist system. Narrow-skill definitions are increasingly seen to be inappropriate for this type of workplace and it has brought into consideration the kind of education workers need within a concept of "broad-band skilling with defined career paths" (Bird, 1991:4)[7]. This initiative also needs to be understood within Cosatu's broader principle of work-place democracy and worker control of production.

The kinds of technological shifts affecting industrial production highlighted by Mathews et al (1988) earlier and emerging in the Cosatu education proposal can also be traced in the National Council of Teachers of Mathematics' (NCTM) motivation for the need to set new national standards in mathematics. This exercise, emerging from the United States, pinpoints some new requirements from the school curriculum in mathematics. Locating their discussion in the observation that

> *"the education system of the industrial age does not meet the economic needs of today ... so that ...the new social goals for education include: mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate."*
>
> (NCTM, 1989:3)

To develop such "mathematically literate workers", the curriculum needs to foster "the learning to value mathematics, confidence in one's own ability, becoming a mathematical problem solver, learning to communicate mathematically and to reason mathematically" (NCTM, 1989:5,6). This goes some of the way to bringing a mathematics education perspective into the debate of how mathematics, science and technology, and in particular,

a technological literacy, can assist in developing a firmer economic base.

The structure which Cosatu is proposing has five levels[8] with a cluster of modules within each level starting at basic mother-tongue literacy and ending with a standard 7 equivalency. In numeracy, this means developing a core of skills and competencies in number and spatial understanding with skill taken to be inclusive of conceptual, executional and application skills, and which can accommodate the work experiences of this constituency.

Cosatu's proposal[9] introduces a set of major shifts in the conceptualisation of non-formal education:

- it is to be certificated and national with an industry-wide system of grading;
- its educational content and orientation is to be much broader than the traditional vocational system;
- it aims to marry practical work skills with academic skills so that worker education is conceived as linked to a career path;
- it expects to have clear links between the formal and non-formal system;
- it conceptualises basic education as going beyond reading and writing to include mathematics, science and the social sciences;
- it specifies the right for paid time off for education and training, as well as employer and state provision of resources and facilities;
- it states that all workers have the right to training;
- it motivates a central role for trade unions in planning and running programmes;
- it locates a re-structured vocational training and education system within the tripartite responsibility of state, industry and trade unions (Kraak, 1991:19).

In many ways, Cosatu is speaking the language of the technological pragmatist, as defined by Ernest (1991). This is highlighted by Cosatu's concern for workplace skills, certification and economic development. However, Cosatu's education proposal is located within a specific social agenda which is not accommodated within this ideological group. The post-Fordist workplace brings challenging concerns to the broad tasks of a workplace education which might provide an interesting location for developing the more substantive social goals previously associated with the public educator.

In sum, Cosatu links the development of the "provision of a general education to both

school-goers and adults" and a dramatic increase in skills training with a larger political and economic programme of restructuring (SALB, 1992:46). Cosatu's ideological location appears fairly similar to that of the ANC though the primary emphasis here is more within the technological pragmatist position. This in itself might be purely strategic as any changes at the work-place affects Cosatu's constituency immediately. It would however be simplistic to suggest that Cosatu and the ANC share this position unproblematically.

2. The Business Sector

Employer led associations have generated their view for workplace education in two sets of National Training Board (NTB) documents: the 1989 "Investigation into Skills Training", and the 1991 "National Training Strategy (NTS)".[10] Their focus is largely on vocational training but there are some important shifts here as well. For example, they speak of "modular and accredited competency based courses, and articulation with the formal system." A complementary view emerges from the Private Sector Education Council (Prisec)[11] which represents a view that although the school certificate gives general competencies, certificate holders cannot do what it says they should be able to do. Hence, Prisec is concerned about specific competencies which might include knowledge, skills and attitudes.

The overall emphasis of the NTS and Prisec is on an employer-led system with serious ambiguities emerging on the role of the state in course accreditation. Some of the weaknesses of the present vocational system are precisely because of these two factors. The trend currently is to rationalise work-based education opportunities with an emerging though still contested shift from management who are beginning to view human resource development both as their responsibility and as an investment for future economic growth. Despite these shifts, it is difficult to evidence any move substantially away from a "narrow conception of the needs of the labour market. Emphasis [is given to] vocationally oriented behavioural and learning skills and values rather than the generic skills and knowledge needed for political, social and economic reconstruction" (NEPI Adult Basic Education, 1992:56). This suggests an industrial trainer framework.

The positions of Cosatu and management appear in many ways to be polarised ideologically as the technological pragmatists and industrial trainers respectively. Whereas both are locked into concerns of improving industrial production, the type of numeracy provision would differ significantly derived from their differing perspectives. However, the

impact of a post-Fordist industrial process which demands worker operational skills of a higher order than those of the industrial trainer, will no doubt show some significant impact.

National Literacy Cooperation

Localized church and community-based literacy projects, brought together in the National Literacy Cooperation (NLC)[12], have mostly offered mother tongue and English literacy to employed and unemployed adults. The NLC organisations, progressive in orientation, have mostly functioned within an "empowering" adult education framework. This has been taken to mean that they use a discussion and negotiation format to generate the content of each course. Central to their approach are concepts like learner centredness[13], critical learning and education for transformation. Their approach can best be described as a Freirian one operating with a dialogic form.

The work of these projects has been to train tutors, establish and coordinate learning groups, and develop learning materials appropriate for each groups' learning needs. Over the past 4 years, the NLC has brought some national networking among these mostly small projects so that common issues have begun to be taken up in a more systematic way.

This learner-centred approach characteristic of most NLC organisations locates them as progressive educators. There is an extensive critique of learner-centredness but what is appropriate here is evidenced in their numeracy work which shows a tension between a "learner-centred as opposed to a mathematics-centredness" (Ernest, 1991:194). This subsequently fails to develop mathematics skills and concepts. However, the progressive educator position compromises questions of social transformation and tends to be "naively apolitical" (Ernest, ibid:195). This is not the case with the NLC projects. Their general philosophical approach would then be closer to the public educator.

The specialist nature of these projects has had to take on board some of the issues being raised by the larger initiatives particularly as these initiatives echo, within the educational sphere, the political changes taking place in the society at large. Questions of scale, content of education and relevance to the changing needs of the economy have placed new pressures on the work of these projects. Questions of certification and national standardisation, for both learners and tutors, raise possibilities for a national curriculum,

clear entry and exit points for different levels, and the development of learning materials out of an extremely localised context to a more generalised situation. However, the NLC brings a particular "experience of development work [which] can be useful and influential resource for wider policy development and planning (NEPI, Adult Basic Education, 1992:58).

There are a number of parallel tensions for the ideological position of both the public educator with its emphasis on social change, and a learner-centred progressive educator. This now needs to also take account of the debates of national accreditation, putting immense pressure on developing an approach to adult numeracy education.

Summary

The purpose of this chapter has been to situate each of the ANC, Cosatu and the NLC ideologically using the categories developed by Ernest. In drawing on the work of various social theorists as shown in chapter 2, he examines these categories for education generally and for mathematics education in particular. This frame, despite its limitations, was therefore seen to be most suitable for locating the education proposals under discussion within the social, and from here focusing on the implications for mathematics education.

The ANC and Cosatu, whilst engaging with issues of education, have their primary focus elsewhere. All the education proposals in one way or another are concerned with developing a "general education" (often referred to as human resource development) as both a resource for the individual and for society.

The ANC's major concern is focused by its political interests and these guide the discursive resources available for education. In this chapter, these have been characterised as marrying the needs of its constituency with the specific imperatives of governance.

The various political resolutions from Cosatu guiding its education initiative are firmly located within the needs of industrial workers. The concerns of economic development are paramount, but within a democratic social order. This locates Cosatu primarily as technological pragmatists but with a strong emphasis on the need for social change towards a socialist order.

In terms of educational goals, the NLC organisations sit most comfortably as public educators even though their social location is at fundamental variance to those in the UK and USA described by Ernest. Their recent concerns of certification, and national standards are as yet not grounded in a substantive theory so that, whilst the technological pragmatist might be a likely location, there is no evidence to suggest this as yet.

Ernest (1991) refers to two broad interest groups which are located as technological pragmatists:

> *"industrialists, government, bureaucrats, scientists and technologists" on the one hand, and "those within the education system, including educational administrators and reformers, scientists, mathematicians, technologists, teachers and educationalists."*
>
> (Ernest (1991:155)

When reflecting on the range of South African interests currently generating education proposals, it might be argued that the ideological position of technological pragmatism could most adequately serve education goals because of its developmental capacity. In terms of a mathematics education however, the technological pragmatist position is unresolved in terms of developing "pure" mathematics or mathematics for use in technology.

NOTES

1. This is stipulated in economic, political or social welfare terms. Dept of Adult Education, UCT (1992)
2. A brief but thorough overview of the ANC's approach to education can be found in Serote (1992).
3. See, for example, Education and Culture for Liberation in Southern Africa, conference papers Gaborone, Foundation of Education With Production, 1981, for some background.
4. Ernest refers to the work of Frankenstein, Abrahams & Bibby, and Bishop which sustained some criticisms in the previous chapter.
5. At the time of writing in January 1993, a revised ERS discussion document has been published. Its most significant statement is that it proposes a single education ministry for formal schooling.
6. See the NECC Press Statement on the Department of National Education's Education Renewal Strategy, 4 June 1991 for a fuller account.
7. This is based on the Australian model which re-organises fragmented skill categories into a few broadly applicable ones. In this way, an entire workforce has the opportunity to develop portable and generic skills training.
8. These 5 modular levels make up the Adult Basic Education (ABE) System which will articulate with the Industry Grading System, the Training Modules in Industry and the Formal Education System. This model has been developed by Numsa - Vocational Training Project, March 1991. See also Appendix B.
9. See also Cosatu's research paper for the NEPI ABE and Human Resources groups.
10. For a full discussion on the proposals contained in these documents, see A Kraak 1991, p14 - 19.
11. Prisec Position Paper No 1, Aug 1990.
12. For a fuller account of the NLC see B Hutton (ed) 1992
13. This is not taken as a static term. In Tell's evaluation for 1987-1991, for example, an extremely interesting account is given of how the initially "pure" Freirian formulation has developed to include the growing experience of the course developers and to accommodate the very explicit requests from tutors to have their educational resource base enriched.

CHAPTER 4

APPRENTICESHIP OR DOMESTICATION?

Whereas the categories developed in chapter 2 .have provided a useful frame for locating educational programmes and policy proposals as was shown in chapter 3, and whilst the ideological location still remains a focus within this chapter, its essential work is to do a preliminary textual analysis of the work of three projects producing numeracy materials. This is motivated by an approach which sees the text as representing

> *"the medium and outcome of a pedagogical struggle over the relationship between knowledge and power as well as a struggle over the construction and the development of the political subject".*
>
> (Aronowitz & Giroux, 1991:215)

The objective is to establish to what extent the materials reflect the educational aims and intentions of the course developers on the one hand, and by developing an analysis of the materials, to suggest to what extent they might fulfil the objectives, in numeracy, of the ANC-Cosatu-NLC grouping discussed in the previous chapter.

The three programmes under review are the English Literacy Project (ELP), Kumon and the Mathematics & Technical Training Consultants (M&T). This selection is broadly representative of the different types of numeracy materials currently available and in use in a variety of locations.

1. ELP is an NGO which is historically grounded in a form of political literacy which sets out to challenge social inequalities through the teaching of literacy. Although there has always been a number component to their literacy work, over the past two years they have begun to develop a more explicit numeracy focus.

2. M&T is a commercially developed programme focusing on the educational needs of the industrial sector. This package aims to fill the perceived gap between what employers expect from employees and what employees are able to offer in terms of numerate ability.

3. Kumon, also commercially produced, is a Japanese package originally developed for school children as a supplement to their school work. This essentially self-instructional individualised programme, is gaining some popularity in the USA and UK with claims of some success in improving the mathematics grades and study habits of school children. At present, it is being modified for use by adult learners.

With guidance from the literature and in the framework of the concerns of this research study, the following categories emerge as appropriate for applying a textual analysis to the three programmes:

i. Educational intentions and outcome: how the expressed intentions of the educational goals are reflected in the materials. This looks to examine the relationship between educational policy and practice. For example, all the programmes suggest that success in numeracy leads to some form of "empowerment" - in some cases personal, whilst in others it is spoken of in economic and mathematical terms. Implicit in the concept of empowerment is a demystification of the knowledge selection process which the content of the programmes reflects.

ii. Tutor and learner subjectivities[1]: A concern is to establish whether the text apprentices learners and tutors to numeracy as a discourse of a mathematical education. An allied concern is how tutors' and learners' "subjective interpretations of reality and value judgements" (Sleeter & Grant, 1991:79) could signify subject positions through the text. Because of the experiences which tutors and learners bring to the pedagogic relation, the text is read in specific ways which makes apparent subject positions.

Background to the three programmes

As seen earlier, nearly all documents proposing changes in education make the broad reference that science and mathematics are central to a technological literacy which in turn, is stated as key to economic development[2]. The world of work needs to be de-mystified with respect to mathematics content[3]. This becomes important when considering this literacy as a literacy of meaning. Such a literacy, together with a shift to the organisation of literacy, numeracy and life skills within a framework of ABE, suggests that numeracy can take on a meaning well beyond the basic functional capacity of reading and writing number.

The specific assumptions within each approach impacts on all aspects of the projects' work: view of the learner, the nature of the mathematical content and materials, the subject positions which the materials presume, tutor training and its responsibility in the learning context, and evaluation. It is to these specifics I now turn.

1. English Literacy Project (ELP).

The numeracy part of ELP's work has developed out of and is largely seen as an extension of its literacy teaching focus as learners were bringing their number based problems to literacy classes. Numeracy, as with literacy, is seen to involve acquiring the skills necessary to "control" the number activities which confront learners in their lives.

The social role which ELP places on education locates it as public educator. The earlier work of Paulo Freire focused a political dynamic for social change through the teaching of literacy. Partly as a response to Bantu Education, Freire's education for "critical consciousness" is seen to be "achieved through `problem posing' education in which students actively choose the issues and objects of study, are co-enquirers with the teacher, and are free to question both the curriculum and pedagogy of schooling" (Ernest, 1991:202). Education is therefore seen as a major force for social change. However at a political level, projects like ELP have tended to be small operations, somewhat marginal to key education struggles. Educational interest then plays itself out in a substantially different way to the public educator as described by Ernest.

However, ELP's learner-centred methodology characterises it more substantively as progressive educator. Substantial critiques have emerged of an unmediated learner-centred approach which question its actual capacity for teaching language. For example, Frank Youngman (1988:190) suggests that a learner-centredness, derived from Freire, "does not suggest how the critical awareness of the students - the `structural perception' - can lead to political action outside of the classroom". Prinsloo and Morphet (1990), in a 10-year evaluation of a Freirian-inspired literacy project, further point to its problematic assumptions about acquisition of language skills.[4] This highlights the paradox of the progressive educator and referred to in the previous chapter. In mathematics education, a serious critique of a learner-centred curriculum can be described as the "conflict between socially embedded and relevant application of mathematics, and academic mathematical structure and theory" (Ernest, 1991:214).

As the domain of NGO's like ELP becomes more public[5], its discourse of literacy/numeracy begins to take on issues like "national standards" and of a more utilitarian numeracy approach. This begins to sound like elements of the position of the technological pragmatists. How this is reflected within learner materials is examined in the textual analysis below. However, ELP's emergent approach to numeracy suggests currently a naive belief which is grounded in a "deferred theory" (Gee, 1990:21) of numeracy.

Textual Analysis

Currently, ELP is producing two types of materials which are relevant to a discussion on numeracy. The one type is specified as numeracy booklets and the other as life-skills booklets. This distinction is determined by the organisation of content so that the numeracy booklets deal with counting and the four operations, five booklets in total of which only one, titled "Counting - A Numeracy Workbook for Adult Literacy Students" is available. The only available life-skills booklet which explicitly includes numeracy is titled "Buying Wisely - A Life Skills Numeracy Workbook for Adult Literacy Students". There is a pre-test for learners to locate their starting points in the workbooks and an evaluative test at the end. Each booklet is planned to take 15 hours. Currently, there is no grading equivalency but ELP is researching this aspect.

(i) Linking educational goals with the text.

A quick summation of ELP's goals for education pinpoints a focus on developing democratic participation for all aspects of social life with education apprenticing learners to a process of social change which should provide access to economic and political life. This commitment to a democratic process is reflected in the workbooks' cover page acknowledging the participation of particular learner groups to the development of the booklets. A further reference asks tutors to evaluate the workbooks with learner groups.

Within the materials, and developed further in the next section here, there is a consistent construction of the learner which flows from such a democratic non-exclusionary intent but which practically resembles a "lowest common denominator" view of the learner. Learners are assumed to bring very little experience or understanding of number concepts. In all likelihood this is not a dominant position amongst learners. In any event, there is no available evidence of this. Further, in terms of ELP's learner-centred approach and

democratic ethos, this appears not to be their intention.

The problem appears to be more in marrying the mixed goals of teaching numeracy with English language teaching. Learners' number concepts should be assumed to be there in the vernacular, so the types of exercises reflected become a question of English language acquisition. It is an illegitimate assumption that if learners do not have the English words that they have not acquired the concept. This point needs no labouring as I feel the authors would not be assuming this even though this is what is being reflected in the materials.

An important strength for numeracy based within literacy is that language considerations can play a complementary role. The many phrases and words that, if dealt with exclusively in number work, are difficult and are far more accessible within a language context. These would include: logical connectives like "if this...then that", "if and only if"; relative words like "more", "less", "bigger"; instructional words like "solve", "estimate"; and, relational words like "for every...", "there is....". These types of relationships are important tools of mathematical thinking[6]. However, language brings its own baggage! One of these is that number work has its own legitimate reading and writing directions besides the "from left to right" convention and this is often not made explicit to neo-literates. In the graphical organisation of information, for example (Counting, p53), a bar chart is used with no explanation given on how to read it, or why this form provides a richer access to data. In the Buying Wisely workbook, calculations tend to confirm the "left to right" writing/reading convention. There is a fair sampling of calculations carried out in columns (p24 & p46) but this shift in format is not sign-posted either as a reading shift or as a shift in pedagogic assumptions. There is almost no evidence of an explicit language-numeracy link within the materials other than the relative words referred to above. These types of reflections would assist in shifting the gaze[7] into the esoteric domain as described in chapter 2.

The organisation of teaching number concepts resembles the traditional lower primary mathematics school curriculum i.e. "counting to 10, then 20, 100, 1000 and finally very big numbers" (Counting, p1). Given the critique of this methodology emerging from traditional schooling and the substantially different educational aims of schooling from ELP, a serious disjuncture emerges of this approach for ELP's educational goals. Within the life-skills booklet, the numerical skills are listed as "comparing, working out percentage discounts, estimating" (Buy Now Pay Later, p1) which interestingly are of a different type to those appearing in the explicitly numeracy workbook.

Throughout the workbooks, the authors use symbols which locate the workbooks within a particular discourse, but at a fairly superficial level. For example, the use of blocks conjure up the use of Diene's[8] blocks which would locate the materials within a progressive educators' approach. However, this claim is at the level of "naive theory" (Gee, 1991:17) as there is no meta-discussion which emerges from the location of progressive educator.

Traditional computation solutions are taught although each operational skill is taught with at least an intended consideration for alternative methods as well as affirming learners' strategies. However, there is a consistent tension between initiating learners into formal methods and use of "popular images" which distance the learner from the assumed seriousness of the academic discourse. The two most prevalent images are of commercial advertisements and forms from banks, the post office, and shopping contexts. Although these are probably selected to assist the learners in their own real-life transactions, they delimit the possibility for the learner is be invited into this epistemologically elaborated space of the academic. This popular imagery is further represented in an infantile form, namely, colouring-in, childish puzzles, general layout, images, notes to the tutors which serve to locate the learner within the infantile.

Mostly, although ELP has a stated goal of building on learner computational strategies, only one expository method is used in the texts and this is tightly context-bound. For example, in the Life-Skills workbook, Buying Wisely (p10 & 11), the percentage symbol, %, is never referred to directly losing the opportunity to elaborate the particular symbolic form and convention of mathematics. Only percentage amounts which "easily" convert to fractions are dealt with, namely, 25%, 33% (with the one-third omitted), 50%, and percentage is only dealt with as less than the original amount. The approach of teaching percent by fractions is by a limited use of a form of a "fraction wall" and "colouring in" appropriate sections of a circle. This severely restricts any possibility for generic skill development.

In both workbooks, there is an evaluative test at the end of the exercises. This is modelled identically on the format of the workbook exercises and over a certain mark allows the tutor to issue a "Student Report" - an in-house certificate. ELP's naive theory is evidenced by its unproblematised engagement with this form of evaluation - unacceptable for ELP's position as public educator but, outside of its position, evaluation is an essential item for the technological pragmatist.

In sum, ELP's strong democratic educational goals located in a social change framework would need to translate to an approach in numeracy which develops generic skills. Although there are a number of situations where "why" questions are asked, these are mostly outside the numerical field. Here, questions are more firmly located within the "how" of a computation.

(ii) Subject positions of tutors & learners.

There are three sets of interactions from the course developers with the tutors - as manager of a class of learners working through the booklet; as a participant in the creation of the booklet referred to above; and as a generator of "discussions and exercises". The first type of interaction is the most substantive, titled "To the teacher" and is elaborated at the bottom of some pages throughout the workbooks in a reduced typeface. These all consist of a set of instructions to the tutor which imply a particular kind of pedagogy and suggest a particular view of the learners.

Each instruction to the tutor is underpinned by a claim which is mostly without justification. For example, in the opening paragraph, counting is said to be an "important skill" which must precede addition and subtraction. Later the tutor is told that "learners find it easier.....", and "learners practice writing the numbers from small to big numbers" as two further examples of this instructional mode. In both workbooks, the tutors are informed that bringing items "of the world .... makes the learning of numbers meaningful and fun". As ELP runs no tutor development programmes, and linked with the pertinent comments earlier, the tutor needs to accept as an act of faith all of these assertions, casting the tutor in a tightly reproductive role.

The pictorial images of learners vary from "middle-aged mums" to "groovy" youngsters, all African. Some query is due as to how these images marry with the activities which these persons engage in within the exercises. The materials fluctuate between two types of engagements from the learners which often seems to be guided by social class - materials with everyday items draw learners in so as to identify with the activity whereas more expensive items are distanced from the learners' action. For example, in Counting (p45, 48 & 50) "counting in very big numbers" which is generally not a familiar everyday experience, deals with money amounts for a lottery, and car and housing sales. In Buying Wisely (p42 & 43), the section on "Hire Purchase" shows only the confusion for the consumer. Incidentally, the opportunity is lost for elaborating some of the principles of the

economic (and mathematical)[9] model on which this system is based.

ELP appears to be taking the general concerns of a learner-centred approach quite seriously, particularly as they reflect some of the recent pressures of building a restructured adult education system referred to in the previous chapter. Although it is affirming in its learner-centred approach, it is now introducing an element of utilitarianism, and it is likely that it ascribes to its more progressive case than the approach described earlier[10]. ELP's current set of learner workbooks with the content organised around number-based themes is specifying that the materials are "skill driven within a context", which is taken to mean the teaching of numerical skills within the social context of learners lives[11].

ELP develops its material in conjunction with the tutors and it expresses some concern now on how the differing social location of the course developers and the learners impacts on their broadly learner-centred approach. This they fear can impact on the contextual issues which their materials draw on.

At another level, there does not seem to be a sufficiently substantial account of the complexity of an approach described as "skill driven within a context". Walkerdine (1988:119) talks about the recontextualisation from a discourse of "context" to one of formal skill as a process of the "suppressing of aspects of the multiplicity of significations contained within other practices". From the materials, what appears to happen is some sign posting to the esoteric (the skill) but not much development out of the public domain. For example, the formal counting system is signposted but only developed within the restricted contexts of the learners' lives. In a further example, with the use of percent described earlier, the public domain content is validated by assigning esoteric domain expressions to the mythical domain and in this way, it claims authority for the activity. Learners are invested with a public domain gaze.

In sum, what emerges from this preliminary analysis is what Ernest (1988:99) calls an "enacted curriculum" which reflects a disjuncture between the educational aims of the curriculum and what the materials actually provide. Despite an approach which sets out to develop formal numeracy skills, the tension between a contextual[12] and an academic approach is not adequately resolved.

Commercially developed packages

Both of these commercially produced packages, Kumon and M&T, tend to describe their intervention as one which will assist both workers and management improve the profitability of the enterprise. The emphasis for each is slightly different and this is partly accounted for in terms of each programme's particular theory of learning. Similarly, there is a differing approach of how each programme is developing the specific content, and on the emphasis placed on individual development. As mentioned in the Introduction, the resources available from these programmes for analysis are not inclusive of the learner worksheets.

2. Kumon

Kumon describes itself as responding to the "corporations' needs to upgrade skills in the workplace".[13] It sets out to improve mathematical skills, and in so doing, claims to improve study habits generally as well as improve qualifications. Kumon, based chiefly on behaviourist principles, sees learning as incremental with knowledge being hierarchically organised. Learning takes place in an individualised way and it entails gaining the skills prescribed within the formal system of mathematics. Skills are understood as exclusively computational and are seen to precede conceptual understanding and application (PC, Garb). Knowledge is taken as neutral and absolute. The content is pre-designed for drill and practice as a basis for incremental mastery. It's claim about the nature of mathematics is at a fairly general level which uses "mathematics as a means to develop the fullest potential of each individual child" (Introducing Kumon Mathematics).

This package appears as to be almost a prototype of materials expected from Ernest's industrial trainer: "useful knowledge is considered to be a set of discrete facts and skills ..... learning is isolated and individualistic ..... learning is based on paper and pencil work" (Ernest, 1991:148), are some of the characteristics attributed to the industrial trainer. The modules and equivalencies of the Kumon package is arranged as follows: Modules 1,2,3 and 4 (Industrial Maths Course - Basic I and II, and Industrial Maths Course - Intermediate I and II) are graded from grade 2 to std 4 and includes counting and the four operations. Each lasts 12 weeks. Modules 5 and 6 (Industrial Maths Course - Advanced I and II) deal with decimal and proper fractions and are equivalent to std 6 (KMWTP). The package has no geometry though there is the offer to "custom design modules" (PC, Garb)

on request.

(i) Linking educational goals with the text.

Kumon claims to develop mathematical skills which are primarily seen as a calculation ability. This leads to conceptual ability, inclusive of "handling problems" (PC, Garb) and which in turn improves study habits and self-image generally. This ethic is developed with 30 minutes of Kumon worksheets daily. Speed and accuracy are important measures of success within a pedagogy of practice and repetition (KMWTP). There is a claim that there is potential for learners to "discover" important mathematical relationships like estimation, patterns and generalisations.

These latter claims are largely unsubstantiated within the system and become a leap of faith. Because of the absence of an epistemologically elaborated message in Kumon, these esoteric domain activities like estimation and generalisations are provided for from the mythical domain so that learners are not apprenticed to the esoteric domain. Behaviourist principles of learning are impressively reflected within the materials though it is important for this to be located within von Glaserfeld's observation of a behaviourist approach: "behaviourists have worked hard to do away with `mentalistic' notions such as meaning, representation and thought" (von Glaserfeld, 1987:10). This underpins the procedurally elaborated structures of the programme through the worksheets of learner exercises consisting of tiny calibrated steps for all computations. The assumption is that once learners have worked through these exercises they will "see" patterns, generalisations, etc. This is largely an invalid assumption as meaning is assigned from the mythical domain.

(ii) Subject positions of tutors & learners.

The work of tutors is focused on the management needs of the programme which depends on close supervision of the learners. Each set of work completed by learners needs to be recorded along with errors made and time taken. Tutors might be trained in placing learners at their appropriate level, i.e., administering the diagnostic test.

Kumon is centrally developed with tutors allowed no space for changes. Kumon specifically discourages any skipping or changing of the worksheets. This takes place centrally and in consultation with the author in Japan.

This general aim of `tutor-proofing' the programme is made explicit - it is intended to be independent of the expertise of the mathematics teacher. Tutors, referred to as `coaches' (KMWTP), occupy the subject positions of some sort of trainers, alternatively, as managers.

Kumon's number-based theme worksheets are organised into six modules and the learners are located at their appropriate level by means of a diagnostic test. Worked examples begin each worksheet which the learner works through before tackling each exercise. These resemble traditional school texts.

Kumon premises its approach as one which `believes' in each person's ability to develop mathematical skills. Besides the generally behaviourist approach, this needs to be contextualized within the use of language which provides a very specific subject position for learners. Learners are most consistently referred to as "trainees" (KMWTP) who are aiming for "mastery" (ibid) of particular skills.

Both learners and tutors are fundamentally passive - the one managing, the other "practising and repeating". The claims of a meta-cognition developing cannot be supported as there is explicit no reference to an epistemology.

3. Mathematics & Technical Training Consultants (M&T).

M&T is a commercial enterprise linked to the needs of industry. The perceived (and actual) gap between the needs of industry and available worker skills is said to impact adversely both on the economy and on the developmental potential of each individual. M&T's broadly socio-constructivist approach is based in learners constructing their "own" mathematical knowledge by solving problems which are pertinent to their lives. Its claim is that this approach develops a sound understanding of mathematical skills.

M&T's content is organised in 3 courses. Course 1, Formative Numeracy, is equivalent to std 1 and includes counting, addition and subtraction. Course 2, Basic Numeracy, is equivalent to std 4 where the learner would be able to function in life and work. Course 3, Functional Numeracy, is equivalent to std 5 and is laying the basis for further study (BNA). There are three different courses within Functional Numeracy and these are roughly geared to the manufacturing sector, the service industries and commerce

respectively. Each starts with a basic education module with the second half more specific to the needs of the specific sector[14].

There is a solid consistency in the M&T programme with socio-constructivism. Socio-constructivism reflects a substantial theoretical development in mathematics education as part of the many significant changes registered in the field over the past 30 years. Briefly, socio-constructivism can be stated as a shift in "emphasis from the student's `correct' replication of what the teacher does, to the student's successful organisation of his or her **own** experience" (von Glaserfeld, 1987:6). A key element of this approach is that it formulates learning as a process of constructing new knowledge by locating it within the learners' cognitive framework. This develops a knowledge-based resource which, being reflective, has the potential to address questions like "what to do in order to produce an answer" (von Glaserfeld, 1987:11). Ideologically, this theory is located as the progressive educator and much of the M&T programme is comfortably located here. Some elements of this includes its referencing to the formal body of mathematical knowledge, its specific focus on the development of the individual so that the need to change society's structures is downplayed[15], and the generally undertheorized engagement of the role of the teacher. Details of this are to be dealt with below. The most substantive shift from the progressive educators' position is that M&T's programme is graded and evaluates learners for both successful completion of a level and to locate them at appropriate levels. This might reflect a certain strategic move for marketability. However, this together with M&T's direct referencing the applicability of mathematics skills to employment suggests elements of the technological pragmatist. At another level, meaning is assigned in such activities from the public to the esoteric domain.

(i) Linking educational goals with the text.

M&T sites two rationales for its approach. The one is detailed as "the basic need of business with regard to mathematics is problem solving ability [and this is specified as the ability to] solve real life problems involving physical quantities [and] making use of the tools of mathematics" (BNA, Appen A:2,3). As this stands, it sets itself in the middle of the abstract-utilitarian debate of mathematics education which remains largely unresolved within this programme. The other is by referencing its approach to international research on learning transfer (BNA p1 and Appendix A p5) and lists the work of the Research Unit for Mathematics, University of Stellenbosch (RUMEUS). This may well be a bid for authoritativeness. The Stellenbosch research has been the cornerstone of the revision of

the formal school curriculum along socio-constructivist lines.

There are two types of objectives specified for this programme. The one relates to its broad educational goals detailed as "the development of people to obtain intellectual independence, self esteem, courage, initiative" (BNA, p1). The other is explicitly mathematical and is described as "positive attitudes towards mathematics, a good understanding of the logic of computation, an ability to communicate effectively about methods of computation, and most importantly, an ability to devise and implement problem-solving strategies" (BNA, p1). The specifically educational goals are located, with no direct substantiation, to the need for an educated worker population for the development of the economy.

The motor for achieving these goals is the general format of the programme. This consists of problems which the learners solve, working mostly in groups. Learners' own methods are encouraged and this is detailed as follows:

> *"students gain an understanding of the idea of computation before they are introduced to formal terms, symbols and concepts. Formal concepts are introduced later, but only to enhance their acquired ability to execute tasks of which they already know the nature, meaning and purpose".*
>
> (BNA, p5)

What emerges from its unresolved position is whether it is concerned about the esoteric domain of mathematics or as a programme to teach certain applied skill. The one consistent mathematical skill referred to is "to devise and implement problem solving strategies" (BNA, p11) giving some detail of this procedure. There appears to be little evidence of "devising" and rather more of "implementing", perhaps a similar imbalance of inductive-deductive reasoning referred to in chapter 2. Symbolic representation, though directly referred to in a number of contexts, appears to be dealt with as an adjunct to learners' methods. This might in itself not be problematic but its treatment remains ambivalent. Lastly, it rejects the teaching and learning of algorithms, without making the distinction of algorithmic thinking, whilst it has drill work as part of its pedagogy. Its reference to the use of the calculator is consistently non-technicist referring specifically to it as a learning and computational tool.

The ambivalent location within the abstract-utilitarian continuum impacts on the consistency of epistemologically elaborated procedures. Learning problems are developed with an eye to the discourse of mathematics whilst at the same time with a concern over about their application possibilities (BNA, Appendix A, p2 pt 1.2 & 1.5; p5 D1). Further, the emphasis of socio-constructivism on learner methods might not favour the development of formal procedures sufficiently. Despite this, this programmes makes serious attempts towards an apprenticeship to mathematics (BNA, p5 pt6; Appendix A p5&6) with its concern for developing generic skills which can be recontextualized to a number of contexts.

(ii) Subject positions of tutors & learners.

M & T tutor training is effected through firstly the methodology of the programme (3 days), and secondly, on the content of each of their courses (1 day each). There is also the offer of follow-up seminars at least 4 weeks after teaching has started. The programme specifies that the role of tutors is one of a facilitator who does not teach, does not verify answers and does not prescribe materials. Rather her role is to set the task, which is in the prescribed workbook, and thereafter she manages the class and the learning processes (PC, E Hallendorf).

The meaning given to "manages" takes a number of forms of which two can clearly be identified. This becomes clear from the description given to the tutor as manager: "probes, encourages, controls and promotes learning" (BNA, p7). The one has the tutor as a passive subject taking the content and process of the tasks as an act of faith, underpinning an elaboration from the mythical domain. For example, the tutor "must trust in the ability of the tasks" (BNA, p7), this whilst the tutors have had no input into the development of the problems[16]. The other has the tutor as someone who is far more generative within the learning process. Tutors who are highly skilled practitioners both in mathematics and facilitation. For example, the tutor is encouraged to use learner mistakes as opportunities for further learning (BNA, p8). This statement is about an induction of the tutor into a mathematics teaching methodology which is located in the esoteric domain of mathematics education.

There is an explicit statement that "the role of the teacher and the method of teaching is crucial to obtain success" (BNA, p6). It explicitly references the high failure in mathematics within schooling to the under preparedness of teachers. This positions the

tutors in what appears to be contradictory subjectivities. Part of this might be explained within the general undertheorization of this area for progressive educators. At a different level, the individualised nature of this form of constructivism, does not assign to either tutors or learners a collective subjectivity for resolving problems[17].

Whilst the methodology of a problem solving approach which explicitly validates learner methods encourages learners to "do" more mathematics, there is some concern over the relationship between these methods and those of formal mathematics. There is also some concern about the relationship between these informally acquired methods and the nature of the "criterion tests" which are used to locate learners at their appropriate levels. A similar concern needs to be raised for the evaluative tests at the end of the course.

At another level, the M&T programme repeatedly alerts learners to be "active learners" but it is not clear whether this might serve as induction to formal mathematics. The very nature of the tutor-learner relationship militates against large-scale implementation.

Summary

Within the three projects referred to in this chapter, number work has mostly been dealt with thematically within two broad categories. The one has the theme generated from within the number-work itself so that it might be addition, percentages, counting, etc. The other has the learners' social context generate the theme through topics like shopping, women's lives or health care. Each of these have generated different types of teaching materials, tutor-training programmes and approaches more generally.

Literacy projects like ELP have tended to approach numeracy in a similar way to their socially contextualised literacy work. For numeracy however, this approach has generally entailed a fairly superficial engagement with the quantitative dimensions of literacy as in recognising, reading and writing numbers. ELP, in developing their recent numeracy booklets, are attempting to move away from some of these limitations. This is generally assisted by the developing framework of ABE.

A more number-based theme approach is often very readily modelled on a traditional school approach so that its form is reminiscent of school texts - discrete content areas, and drill and practice of computational skills with very little understanding of the skills, and

little social or contextual relationship developed outside of the number work. In many ways the Kumon package falls into this category.

The socio-constructivist approach of M&T reflects some capacity for mediating the kind of polarity typified above. It is looking to integrate number theme teaching with the social role numbers play within a mathematical content. It is possible to argue that the activities of this programme most strongly assign meaning from the esoteric domain of mathematics education.

Despite the problems with both these general approaches, a general strength of ELP and M&T is that they both claim space for learners to show their coping and self-taught strategies. The programmes begin with either a consideration of what illiterate people can do with number as it is not uncommon to meet illiterate adults who can handle concretised aspects of number competently in the form of mental arithmetic as in transactions with money or measurement of time and mass, or, with what people should be able to achieve once number work has been mastered. Flowing from this, the programmes' content is mostly guided by two considerations: the numeracy, or mathematics, to be taught must be relevant to the learners' lives, and the content must harness learners' practical knowledge whether work or elsewhere based. This can be characterised as bringing the "world" into formal mathematics whilst making some attempt to re-defining the nature of this formal content. The analysis provided by the social domains of the descriptive language (Dowling, 1992) has attempted to make explicit where meanings have been assigned from.

Content is often determined as to whether numeracy begins within mother-tongue literacy work, integrated within the literacy content, or as a separate area completely. The work of all three programmes is organised in modules. Content is also governed by whether the programme is located within an NGO or a commercial programme, and the theory of learning which informs their work.

All the programmes deal with counting and the four operations as the basic tools of number work. There is some discussion, particularly from M&T, as to the order of teaching the operations as well as to the method. The natural number system gets extended in various ways and is dependant on the context and approach of the materials. So, for example, common fractions may be dealt with in as far as they are linked to language use. Computations with fractions are often taught using practical materials like the "fraction wall". Decimals might be taught exclusively with the use of money. Place

value often is prioritised as is manipulations with 10's. Percentage is a common topic as is estimation.

The impetus for developing curriculum materials for adult numeracy is currently grounded in a critical examination of what already exists in the field. The work of this chapter has generally been grounded within such a pragmatic position. It was felt that this could best be achieved by not only identifying the ideological location of the programmes as stated in their goals, but to examine how the numeracy materials themselves reflected the intentions of the course developers and programmes more generally. Further, as education goals are often coined in the language of outcome, locating the numeracy discourse of the materials has served to identify learner and tutor subjectivities.

Two questions have guided this analysis. The first sought to develop a coherent narrative of evidence of the internal coherence of each programme. The second located this narrative within an examination of what kind of "mathematically literate" subjectivities was provided for tutors and learners.

At the level of goals and educational outcome, ELP has developed a substantial approach to literacy which is premised on social change. However, in terms of numeracy this is generally undertheorized so that the materials reflect a weak case for developing a sound numeracy resonant with the educational goals. Both Kumon and M&T have a more substantial theory of numeracy informing their work though from very different perspectives. Kumon's numeracy materials link well with their educational goals though the outcomes are premised on unsubstantiated claims. This programme as is, lacks the capacity for addressing any social pressures for numeracy. Finally, M&T shows the most promise in terms of a socially located numeracy which is conscious of the needs of economic development. The particular shortcomings however would need to be addressed more tightly within a political and strategic framework.

These three programmes are each exemplars of possible discourses for numeracy under consideration within the research study. Broadly, ELP demonstrates numeracy within literacy; Kumon shows numeracy as arithmetic; whilst M&T falls mostly within a numeracy as mathematics education. The implications of choice are considered here in relation to the adult education tasks developed from an analysis of the Cosatu, ANC and NLC proposals.

The work of the last chapter is to reference some of these conclusions alongside those of the analysis of the education proposals from chapter 3.

NOTES

1. I have drawn on the work-in-progress of Z Davis who is extending Dowling's "language of description" to a "language of production". See, the forthcoming proceedings of the Political Dimensions of Mathematics Education (in press).
2. At the moment, this is constructed as unproblematic yet it raises questions about the content of a mathematics education which is oriented towards the development of technology. Perhaps there needs to be a more critical appraisal of the relationship to mathematics, technology and development. This process could also serve to delimit a social change dimension to the technological pragmatist category.
3. See for example the Maths in Work project referred to earlier.
4. For implications for numeracy teaching, see for example D Angelis, "Theory within the Practice" in Transformations?, 1992. However, see Frankenstein (1987) for a very useful elaboration of a Freirian approach to teaching statistics.
5. "Domain" and "public" are given their common meaning here rather than that given by Dowling (1992).
6. Craig & Winter (1991/92) elaborate elements of standard and mathematical language use.
7. See Dowling (1992) for this usage.
8. Valerie Walkerdine (1988:119) draws an interesting observation in the subjectivities of Dienes' differing discourse for teachers and children, the former being somewhat moral whilst the latter addressed in a "softer tone".
9. Frankensteins' work is characterised by attempts to explain the economic through the use of statistics, an approach which would alter the nature of the ELP materials.
10. See for example, J.Crandall & S.Imel, Learn & Teach (1991) and J.Godden (1990) for this parallel possibility for functionality, derived from Unesco and now carrying some possibility for elaborating a utilitarianism.
11. Personal communication, Dawn Norton materials developer for ELP. March 1992.
12. Evans (1988) elaborates context with a concern for its use within "abstractly-conceived tasks".
13. Personal communication, Jack Garb, the representative in South Africa of Kumon and based in Johannesburg, April 1992.
14. Personal communication, Eric Hallendorf, course developer, April 1992.

15. Stephen Lerman (1989) makes the distinction between a weak and a radical constructivism. In terms of this distinction, M&T would be classified as weak in that social institutions and formal mathematical knowledge is not questioned.

16. Piet Human, from RUMEUS, makes the point that the development of problems is highly specialised and an unrealistic demand to place on tutors. The skill of the materials developer is to develop problems which carry sound number concepts as well as link this to learners' experience. Personal communication, April 1992.

17. Both Kibi (1992) and Adler (1992) show concern for this.

CHAPTER 5

SOME CONCLUSIONS - GOING FOR CLOSURE TO MOVE AHEAD

In the previous chapters, a theoretical framework for adult numeracy was elaborated within the education proposals of the ANC-Cosatu-NLC group, and then within the numeracy materials of three programmes. This exercise served to develop an understanding, at the ideological level, of the nature of each of their approaches.

The second concern has been to establish to what extent these numeracy materials induct learners into dominant subject positions through their apprenticeship to numeracy. This final chapter is primarily concerned about looking at the implications of the issues which have emerged as part of this investigation.

But it is as well to get a set of disclaimers out of the way. Firstly, this research study makes what is arguably a controversial move: it has posed the work of three numeracy programmes against objectives which, in varying ways, they largely did not set for themselves. For example, they have been interrogated by a "people's education" discourse of the ANC, Cosatu and the NLC; they make only a limited claim to being about a mathematics education, and then only in relation to work productivity; and they have been given some location within a post-structuralist discourse of multiple subject positions. However, though they may not have been developed from within any of these concerns, this study has argued for the importance and relevance of each of these analytical frames.

Secondly, throughout this report, there has been a bit of an `attitude' to utilitarianism, whereas the key motive for engaging with this research has been precisely for its `use-value'. As a practitioner, I felt that the inconsistent construction of adult numeracy needed to be elaborated. The real concern has been that a limited focus on use, which is what utilitarianism is about, does not provide an adequate elaboration of adult numeracy.

Finally, there has been only a minimal allusion to some of the contestations about the nature of mathematical knowledge itself. An apt description puts it as a "system of statements as statements of fact precisely because it claims a universal applicability - a

rationality devoid of any content which can describe and therefore can explain anything" (Walkerdine, 1988,187), a powerful case for its neutral discourse. Whilst the social critiques offered here have contextualized the development of the dominant discourse in mathematics, there is a wealth of comment in this area which falls outside the concern of this report.[1]

Disclaimers assist in developing a clearer focus of the task at hand by setting aside tangential points to its elaboration. The remainder of this chapter will firstly look at what this research study has achieved. Secondly, it looks at the implications of these for adult numeracy.

1. What This Study Has Done

1.1 Adult Numeracy Speaking Mathematically

The entry point to the research has been to develop a coherent language of analysis for adult numeracy materials, with reference to their development, their viability in a teaching-learning situation, and as to how the discursive resources in the educational objectives are elaborated.

The original research brief had entailed surveying a more substantial range of materials than those that finally found their way here. From this survey, arose this study's first key concern. In the materials and approaches generally, it was apparent that adult numeracy was not `naturally' taken to be an element of mathematics education. The first urgent task has therefore been to develop a base from which to substantiate what had been taken as a `common sense truth', that of adult numeracy as an element of a mathematical education.

The one level of substantiation is best illustrated with an example elaborated through this "Baby Chart" (See Appendix C). A weekly task which mothers with young children undertake is a visit to the nutrition clinic[2] where the growth and development of their children is monitored on this Baby Chart. The relationship which these charts represent graphically is of age-to-weight. Across the chart is a printed line showing the growth line of the `average' baby. At regular intervals, the baby is weighed and a Cartesian point is indicated on the chart. These points are joined so that over a period of time a growth pattern emerges. Part of the chart is coloured in red, a colour coded indicator of `danger'

should the baby's line lie within this space. Most women (and men)[3] are utterly mystified by these charts.

Besides this being an immediate challenge within that teaching situation, this context (problem) also clearly "carries the germ(s) of important mathematical ideas[4]". With only a consideration of content, these would include whole and decimal numbers, Cartesian axis with two variables, addition and subtraction. Whilst the Baby Chart is assigning meaning from the public domain with the likelihood of a procedural elaboration (Dowling, 1992) within this clinic situation, what became interesting, precisely because of the complexity of the metaphor, was to consider how meaning could be assigned from the esoteric domain - what, for example, Walkerdine (1988:119) describes as a "suppression" of some elements in the "chain of signification" so as to recontextualize this metaphor within the esoteric domain. The concern is the choice of shrinkage of the mothers into the baby chart, or for their development into generically skilled individuals. This latter approach[5] seems to be a viable pedagogic choice.

To a large extent, the Baby Chart metaphor has not been directly developed within this research study . The approach of an epistemic adult numeracy has rather been substantiated within the adult education discourse of a "good general education" with an eye to economic development. This discourse looks to elaborate the links between the pedagogic and the political.

1.2 Adult Numeracy Speaking Politically

Adult numeracy has been inserted into the education proposals of the ANC, Cosatu and the NLC, through an examination of the ideological locations of their education proposals. Because the approaches of at least the ANC and Cosatu is informed by a "national development strategy aimed at the restructuring of the economy, economic growth and redistribution, and the democratisation of society" (draft document National Education & Training Forum[6], 1993), the educational goals alongside the social goals, present a slightly contradictory situation. Education is spoken of in terms of a "good general education", yet within the language of redress and democratisation.

Besides these complications inherent within the proposals, Ernest (1991) further elaborates the complexity of pinning down the ideology of interest groups in education and with a specific interest in mathematics education: "the ideological positions themselves

are simplified and to some extent arbitrary in the choice of elements included [to develop a] family of overlapping ideologies ....to composites" (Ernest, 1991:140) of positions within single groupings. It is within such constraints that the ANC, Cosatu and the NLC have been ideologically located.

The position of the ANC and Cosatu can be summarised as follows, and it is from this orientation that their ideological location, the technological pragmatist, has been developed:

> *"ABE should be part of a national development policy aimed at the restructuring of the economy, redistribution, and political democratisation. This approach assumes a strong interventionist state in order to correct the social inequalities of apartheid, such as high illiteracy, and regulate the weaknesses of the market, such as skill shortages. The provision would be co-ordinated within a national framework of affirmative action".*
>
> (NEPI ABE, 1992:67)

The greatest strength of the technological pragmatist location is that "it relates education to the goals and needs of society" (Ernest, 1991:165) but, it sets no agenda for social change and the view it holds of mathematics has been limited to a utilitarian function. However, the interests of this grouping, including the industrial sector and referred to in detail in chapter 3, are increasingly realising that a narrow skills definition is inappropriate for the workplace of the future and that rather "general knowledge and transferable skills suit industry better" (Ernest, 1991:165). This begins to be located in a "general education discourse" with generic skills development.

The NLC organisations are more ambiguous in their education goals. The only shifts evidenced within their location of the progressive educator are generally undertheorised.

1.3 Adult Numeracy Speaking Pedagogically

ABE, and specifically numeracy, has been formulated as a broad based education and mostly distinct from a training and vocational approach. Adult numeracy has been described as an element of a mathematical education so that an examination of the materials of existing numeracy programmes was undertaken to explore their approach to the development of numeracy skills. The task of the preliminary textual analysis was

explicitly informed by this motivation. It has made selective use of the social domains of mathematics education (Dowling, 1992), and was concerned about how numerical / mathematical content was elaborated.

Content, as a directory of particular numerical themes, is not substantially different in the three programmes. The key difference emerges at an ideological level and, in particular, in the presentation of the learning materials. Broadly, this becomes more a question of pedagogy and the analysis was interested in an examination of how "the ideal learner" was created by the materials so that by this definition, pedagogic resistance and change could become more focused as subject positions were made visible through my analysis. The key question was to elaborate on learner subjectivities, which in terms of an explicitly educational framework, needs an induction into the dominant discourse in mathematics education.

Two of the three programmes, ELP and Kumon, elaborate their text in a way which is rule-governed with very little explanation of the reasons behind these rules. In Dowling's (1992) terms, this is text which is procedurally elaborated. The third programme, M&T, tends to show a more epistemic approach and avoid rules altogether though maintaining an eye on the actual acquisition[7] of skills. The weakness of this programme is that it is too tightly governed by a specific theory of learning which lacks a strategic developmental capacity and delimits the epistemic, in my view, in a restricted way.

2. Implications of This Research

The implications of this research flow from the study's key statement which is substantiated from the social goals of education broadly, and from the imperatives of the workplace: approaches to adult numeracy need to be grounded in a theoretical framework of a mathematical education. The analytical framework of this study has plotted the specifities of a mathematical education and numeracy work against the broad social context and goals.

It has shown that if adult numeracy priorities use, the pedagogic practice makes available submissive subject positions for tutors and learners which contradicts the social goals which the programmes claim. If, at the other end, priority is given to the abstract end of the continuum, this disembedded specificity of use also inhibits growth and understanding.

This analytical framework has indicated how an adult numeracy education needs to develop both a use capacity and generic skills. Further, by focusing "on the specificity of the social structuring of context rather than perpetrating hegomonic action on the part of a dominant social group" (Dowling, 1991:116), it lays a concrete basis for the development of an adult numeracy which is concerned with social change.

The specific implications are to be elaborated in two areas. The one is to make some comment on how an epistemic adult numeracy might be developed. This needs to take account of a national and accredited system of provision. The other looks at some implications for tutor training.

2.1. None of the programmes is adequately concerned with an adult numeracy as an element of a mathematical education. The apprenticeship which develops from each of these packages is somewhat different. In one case, a socially defined numeracy is positioned alongside literacy. In another, arithmetic along with its "partner-in-arms, basic skills" (Mathews, 1991:151) as acontextual computational operations is stressed, whilst the third, apprentices into a limited epistemic mathematics education. This programme in particular does not take sufficient account of the transformations that take place when essentially non-mathematical practices are recontextualized as a mathematics education (Dowling, 1988:4).

At least a preliminary understanding of some of the elements of generic skills needs to be developed. These skills are often described as issues of outcome, and sometimes they are spoken of as "assessment objectives" (Dowling, 1988:15) which describe what learners should be able to do.

The starting point then is that adult numeracy is about more than developing socially defined computational skills. A traditional version of an epistemic mathematical education is that of the old humanists. This ideological grouping is concerned with the development of mathematics "as a body of pure objective knowledge, based on reason and logic" (Ernest, 1991:169). Although the mathematical old humanists is an extremely powerful position in mathematics education, its elitist social goals which are directly reflected within mathematics education, are inappropriate for a `people's' discourse of adult numeracy. This discourse, at the level of a "people's mathematics"[8], is about connecting theory with practice, it is about challenging the mental-manual dichotomy, and it locates mathematics education within a social discourse so that race, class and gender inequalities can be

challenged (Julie, 1991:36).

This approach, whilst elaborating the social goals of education, remains fairly fuzzy on epistemology. Without a more systematic elaboration, it remains a "good intentions" exercise at the level of rhetoric. An epistemic adult numeracy would need to be concerned with the kinds of concepts which are not so much related to content parameters but ones which elaborate a critical pedagogy. I would like to explore one or two of them here.

Chapter 2 pointed out the articulation of the different numeracies of formal learning and informal life and work situations. It raised specifically the complexity of context-based learning materials. This is elaborated by Strasser et al (1991:166) who point out that in some situations the mathematics is so embedded in the activity that it appears indistinguishable from the activity itself whilst in other situations, particularly in technology linked activities, the mathematics appears "only as a useful tool". Central, however to understanding the context, is an understanding of learners resources which will serve to mediate their engagement with that context. Yet, in a comparison of "informal mathematics and school mathematics" (Harris & Evans, 1991:129) over a number of categories, the ability to work precisely and to generalise to other contexts are two distinguishing features between these two forms. This locates two specific discursive resources available to a mathematical education and which have been developed from work-place programmes.

Generalizable skills are located within an epistemic understanding. Such skills can be applied to new situations and this process usually requires some level of mathematical modelling[9] - a process of "mathematizing and interpreting" information (Ernest, 1991:155). Strasser et al (1991:167) elaborates this as follows:

> *"modelling of a problem, of an extra-mathematical situation in terms of mathematical concepts, the solution of the mathematical problem and a re-interpretation of the mathematical solution in terms of the situation one has modelled".*

This essentially inductive approach links procedurally and epistemologically elaborated messages.

A final area for further elaboration is what Strasser et al (1991:163) have called "whole

task teaching" and what Brown et al (1989:37) have called a "research-based approach to curriculum". Both of these challenge hierarchically arranged "topic based curriculum" (Brown et al, 1989:24) organisation.

2.2. In all the programmes, the only discourse available to tutors is one of reproducing the text. Tutors are not involved in any substantive way in the development of the texts nor do any of the programmes provide a systematic process of tutor education. Each programme prepares tutors to teach only their specific package as some sort of induction. The former constraint undermines any democratic intent of the programme whilst the latter places severe restrictions on tutors' activity. Yet, Jane Castle (1990:7) makes the point that

> *"numeracy teachers may need more extensive training than literacy teachers, since they themselves may have to gain knowledge and confidence in mathematics before assisting others in the process of acquiring number skills".*

Besides this specific situation existing within these three programmes, the effect of an under-professionalized[10] tutor population is a serious limit on any possibility of generic teaching. Dowling (1988:20) makes a distinction in pedagogy in the "academic" and the "mundane" curriculum. Both have elements of "exposition, routine and evaluation" whilst the academic also has the added task of decoding. Further, teaching based on mathematical modelling, described as a "circular structure of the application process" (Strasser et al, 1991:167), makes teaching a very different process to reproduction. The previous section's elaborations would be of no avail without a systematic tutor training programme which develops academic and professional skills.

In conclusion, the powerful formalising trend in adult basic education, whilst heralded as an essential move in the correct direction, needs to keep its eye on the lessons from the formal system. Apple and Christian-Smith (1991:2) caution as follows:

> *"movement to the right .... for the centralisation of authority over teaching and curriculum, often cleverly disguised as `democratic' reforms, are hardly off the drawing board before new management proposals or privatisation initiatives are introduced".*

A great deal needs to be done to what exists in adult numeracy education so that elements of a mathematical education gain a clearer representation. This contribution of an epistemic numeracy education might serve as contribution to that debate.

NOTES

1. Anthony Giddens (1990) uses the concept of neutral "expert systems" developed from mathematical modelling. This provides an interesting `neutral' case for social description.
2. This example emerges from regular numeracy classes held weekly for mothers visiting such a clinic, Khayalitsha, Cape Town, author's notes.
3. So did a sizeable group of mathematicians and mathematics educators when presented with this chart at SAMSE 1991, Maputo.
4. Personal communication, Piet Human, April 1992, in his description of an essential characteristic of mathematical problems within their socio-constructivist programme.
5. There is no implication that other approaches, for example life-skills or literacy, would not also be viable. The choice made here is perhaps understood in terms of my own interest in adult numeracy.
6. This is made up of the participants of the National Education Conference, the business sector and government authorities responsible for education and training. The ANC and Cosatu are key initiators of its establishment.
7. The usage here is that of Gee (1991).
8. Besides the elaboration of People's Education referred to in chapter 1, Julie (1991) has edited a collection of contributions which focuses on mathematics education specifically.
9. Skovsmose (1989 & 1990) shows that mathematical modelling is itself fraught with complex and largely invisible power relations. This was discussed in chapter 2 in relation to the nature of the work of mathematicians.
10. Motala's (1992) study on the needs of tutor training in non-formal education elaborates the seriousness of the situation.

APPENDIX A

ACTIVITY MESSAGE STRUCTURE

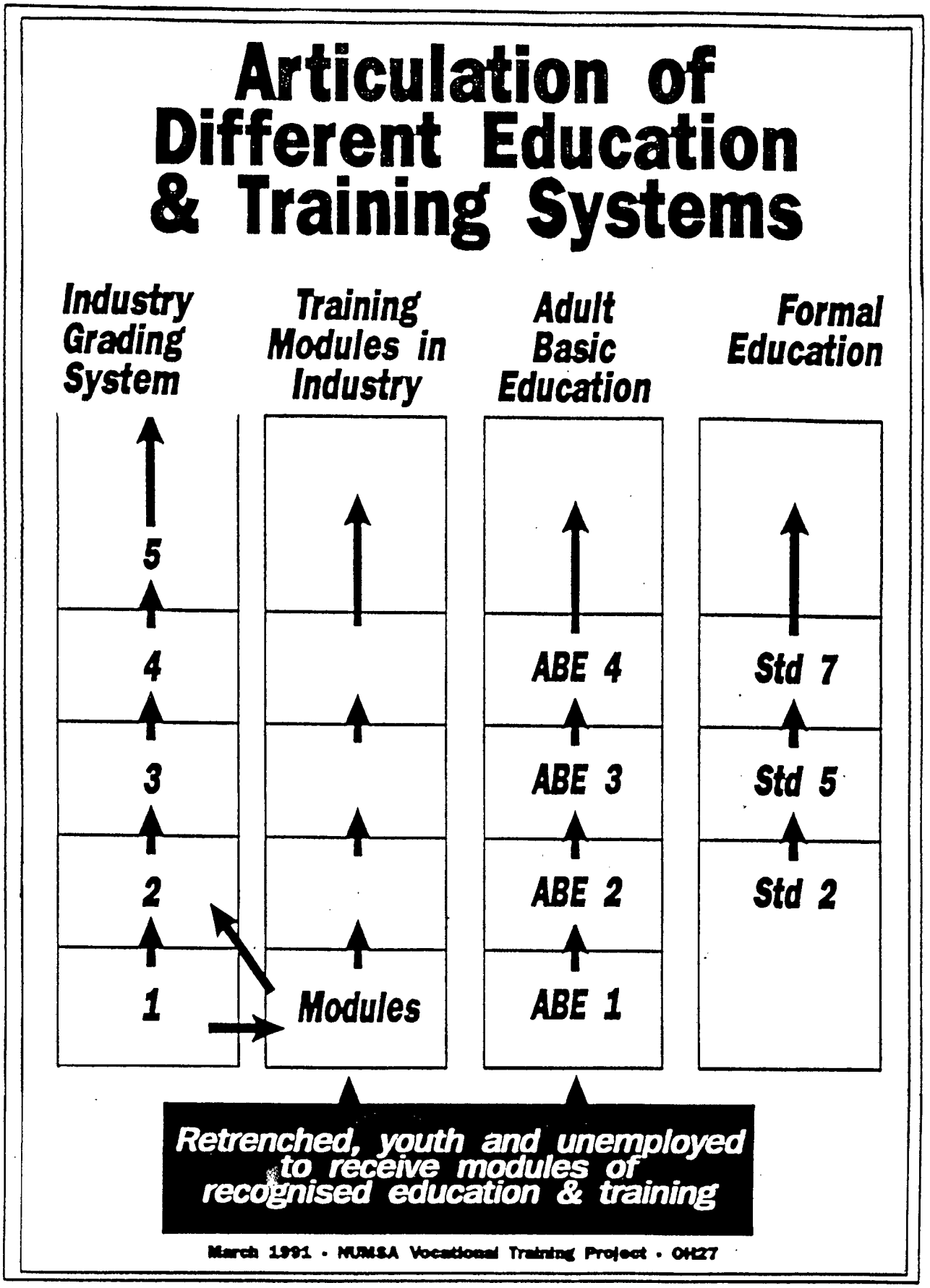
DOMAIN

Esoteric	Metaphorical
Articulation of possible topics.	Metaphorical recontextualisations.
Low activity ambiguity.	Intermediate activity ambiguity.
Gaze inoperative.	Apparent gaze reversal.
Public	**Mythical**
Possible relocations.	Mythical recontextualisations.
High activity ambiguity.	Intermediate activity ambiguity.
Gaze inexplicit.	Visible gaze.

From Dowling, 1992a, p.26

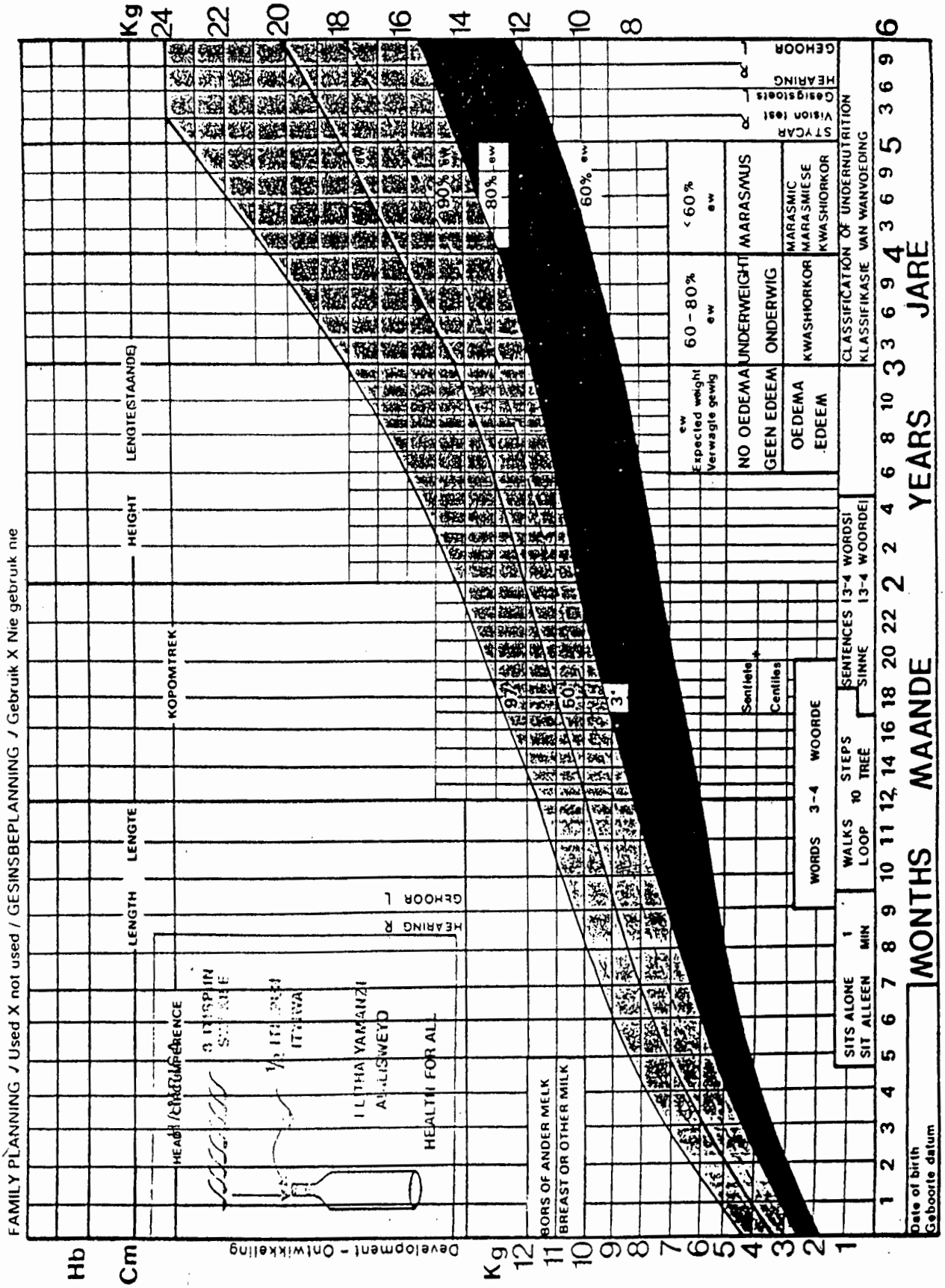
APPENDIX B

ARTICULATION OF DIFFERENT EDUCATION & TRAINING SYSTEMS



APPENDIX C

THE BABY CHART



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