THE POLITICS OF KNOWLEDGE

Tracing the trajectory of the Natural Science Curriculum

Anitha Ramsuran

THE POLITICS OF KNOWLEDGE

Tracing the trajectory of the Natural Science

Anitha Ramsuran

Dissertation Submitted in Fulfillment of the Requirements for a Doctoral Degree in Education (D. Ed.) in the Faculty of Education at the University of KwaZulu Natal

Promoter

Prof. Clifford Keith Malcolm- University of KwaZulu Natal

April 2005

Abstract

Knowledge production or research in South Africa, as elsewhere in the world, does not occur within 'innocent' spaces devoid of personal, social, political, economic and cultural contexts (Singh, 2000). This study explores knowledge production at the level of policy. It questions in the review of the school's curriculum policy in general, and the science curriculum policy in particular: What becomes new? What is different? What remains the same? What is the policy problem? Who is the policy population that is the target of such policies? Why is there such a universal dimension of what should be taught in science, and hence what science is? Why is the conceptual knowledge of the science curriculum and the conception of scientific literacy around the world much the same? At the level of research, what is the most illuminative way to seek answers to these questions? The study explores the theoretical, methodological and contextual constructs that frame the conception of scientific literacy.

This thesis presents a critical analysis of the policy process and policy documents for two reform periods in South Africa. The theoretical constructs deployed are policy archaeology, ideology, inclusivity, governmentality and professionalisation. I argue in this study that the latter two constructs are regularities that are necessary for the emergence of the policy problem, they shape the social construction of the policy problem and they constitute and shape the range of policy solutions. I posit that these regularities are necessary for the social construction of the policy problem in both the C2005 and the RNCS processes. These regularities intersect in a complex, grid-like fashion on the policy-problem axis. These intersecting regularities makes it possible for the policy problem to emerge as a problem, constructs the problem, and constitutes the problem as an 'object' of social visibility. I argue that ideological shifts in the conception of scientific literacy are constituted by these two regularities.

I conclude the thesis by drawing out five significant policy lessons: (i) An 'ideal' that makes intellectual sense but does not fit conditions in society can exacerbate the problems it seeks to solve; (ii) 'Change is only as effective as the smallest unit': in the policymaking arena the smallest unit is the policy writers, in the arena of practice it is the classroom teacher; (iii) Timing determines what is possible: the socio-political climate of 1994 resulted in some important silences- especially from conservatives and scientists; (iv) In the science policy documents the definition of scientific literacy is epistemological at two levels: the idea that scientific literacy can be defined and constitutes individual knowledge, and the view of knowledge in the policy documents; and (v) The policy process and the policy documents challenged hegemony of structure and the epistemology of knowledge.

Key Terms:

policy archaeology; critical policy analysis; governmentality; ideology;

professionalisation; inclusivity.

Declaration of Originality

I, Anitha Ramsuran, hereby declare that this dissertation is my own work, and has not been submitted previously for any degree at any university.

....
A. Ramsuran

Dedication

To my Parents

Who had limited formal schooling
And continued exposure to knowledge
They could not call their own
But realised what knowledge was worth knowing
In a country they felt they did not belong
Who have inspired my pursuit of critical scholarship
Beyond the realms of legislative space

Acknowledgements

I owe much to:

1. My parents; brothers Naresh (and his wife Asha), Pranesh (and his son Adhir); sisters Shamitha, Premesha (and her family: Ishwar, Letrisha, Rishana and Sarshen), Vanitha (and her family: Vinod, Shailen and Tashlin); my extended family: Ashveer, Kaveer, Avika, Naveen and Nishal, and to a very special person: Ken Karikan who shared in my triumphs and failures and has taught me the rightness of 'now', all of you who make work of this nature worthwhile.

2. Professor Cliff Malcolm: my promoter, supervisor, mentor and dear friend, whose belief in me bolstered mine and whose confidence in my writing far outweighs mine. Thank you.

3. Professor Jonathan Jansen: my mentor and inspiration.

4. Dr Volker Wedekind: for giving me space and time and constant support under your headship.

5. The Spencer Foundation: for providing the funding to complete my Phd full time, for the opportunity to obtain support from leading academics here and abroad and for the opportunity to build a fellowship with other Spencer fellows. For the Spencer fellows at the institution that I work at: Pontso Moorosi, Nonhlanhla Mthyane and Devika Naidoo, thank you for being there and being my most welcome critics.

6. Professor Martin Carnoy for making it possible to visit Stanford and the hospitality you extended during that period.

7. Professors Pam Christie, Christine Keitel-Kreidt and Linda Chisholm for putting your faith in me.

8. My colleagues and friends in the doctoral programme on the Westville Campus- Dr Sue Singh, Prof Michael Samuel, Prof Renuka Vithal, TT Bhengu, Matseapo, Rajesh Neerchand, Karabo and Dumisani.

9. My dear friends Dr Anusha Lucen and Jackie Naidoo: for your depth of understanding and willingness to share.

10. Tracey Kareen Andrews, the administrator of the doctoral programme, thank you for being a veritable rock and a constant source of advice, camaraderie and laughs.

11. Natasha Naidoo, Simmi Thaver, Ashik Bridgmohan, Geshree Naicker who make less of a chore what I do at work.

12. The participants in my study and the external examiners of the thesis.

Table of Contents

Chapter Three

Policy Methodology

Chapter Four

Though There be Madness, Yet There is Method!

Chapter Five

Unmasking Shifting Ideologies in the Conception of Scientific Literacy

Chapter Six

Digging deeper: Excavating the Policy Process- The Rules of the Game

Chapter Seven

Policy Archaeology Applied: The Grid of Intersecting Social Regularities

Chapter Eight

Inclusivity: Is it possible to base systemic curriculum reform on principles of social justice?

Chapter Nine

Policy Lessons and Recommendations

List of Figures

List of Acronyms

AAAS	American Association for the Advancement of Science
ABET	Adult Basic Education and Training
C2005	Curriculum 2005
CEPD	Centre for Education Policy Development
CTSC	Curriculum Technical Sub- Committee
DOE	Department of Education
GEAR	Growth Employment and Redistribution
GET	General Education and Training
GETC	General Education and Training Certificate
GICD	Gauteng Institute of Curriculum Development
IKS	Indigenous Knowledge System
INSET	In-service Education and Training
LAC	Learning Area Committee
MPC	Ministerial Project Committee
NCS	National Curriculum Statement
NGO	Non Government Organisation
NECC	National Education Coordinating Committee
NEPI	National Education Policy Investigation
NETF	National Education Training Forum
NQF	National Qualifications Framework
NRC	National Research Council
NS	Natural Science
OBE	Outcomes Based Education
OECD	Organisation for Economic Cooperation and Development
PISA	Programme for International Student Assessment
RDP	Reconstruction and Development
RADMASTE	Research and Development in Mathematics, Science and Technology Education
RNCS	Revised National Curriculum Statement
SAARMSTE	Southern African Association for Research in Mathematics, Science and Technology Education.
SAQA	South African Qualifications Authority
SETC	Science and Technology Education Commission
SO	Specific Outcome
TIMMS	Third International Mathematics and Science Studies

List of Tables

Chapter 1

THE POLITICS OF KNOWLEDGE
TRACING THE TRAJECTORY OF THE NATURAL SCIENCE CURRICULUM

But, then, what is philosophy today- philosophical activity, I mean-if it is not the critical work that thought brings to bear on it-self? In what does it consist, if not in the endeavor to know how and to what extent it might be possible to think differently, instead of legitimating what is already known (Foucault, 1985, p9).

1.1. INTRODUCING THE ARGUMENT

It is perhaps fitting that I write up this thesis a month away from South Africa's third democratic election and after ten years of democracy. While political parties increase their campaign of 'promises', the African National Congress (the dominant political party) build into their campaign successes in a number of social spheres, yet sadly, not much is mentioned in terms of successes in education. Opposition parties promise a fundamental and deep change in the social order that has eluded a decade of democracy. Have the two periods of curriculum reform since 1994 changed the existing social order? What drives the state to constantly review the school's curriculum in general and the science curriculum in particular? What becomes new? What is different? What remains the same? What is the policy problem? Who is the policy population that is the target of such policies? Why is there such a universal dimension of what should be taught in science, and hence what science is? Why is the conceptual knowledge of the science curriculum and the conception of scientific literacy around the world much the same? At the level of research, what is the most illuminative way to seek answers to these questions?

In the new South Africa, multiculturalism, economic development, infrastructure, service provision and globalization, etc. have placed enormous pressures on education, science curriculum policies and definitions of science in the curriculum. Pre-1994, South African education was characterized by an intentionally uniform and predictable curriculum environment. The apartheid state managed a centralized curriculum policy system that was described as racist, Euro-centered, sexist, authoritarian, prescriptive, unchanging, context-blind and discriminatory (Jansen, 1999a). The year 1990 signaled numerous political changes inside South Africa. Competing social movements and political actors began to stake their curriculum position in anticipation of South Africa's first democratic, non-racial elections. As part of educational reform, the conception of what was most worth learning in the name of science education – which I will refer to as 'scientific literacy' – was bound to change.

In 1994, the Curriculum Technical Sub-Committee (CTSC), headed by Mary Metcalfe, deliberated on the establishment of a long- term curriculum framework. Since such a framework would take at least 2-3 years to establish, the CTSC decided to consider short-term syllabus revision as one means of intervening in the education crisis. Field Committees were set up for each subject area. The Committees were to address: (1) the factual incorrectness of subject matter in the light of socio-political changes and developments in the field of study; (2) content which did not reflect sensitivity to the perspectives of different groups in South Africa and; (3) the possible consolidation of syllabuses given that different departments inherited 19 different syllabuses from the different ex-departments of education for the same school subject. The committees interpreted this brief to mean the removal of outdated, inaccurate and insensitive content from school syllabuses and to consolidate fragmented syllabuses (Jansen, 1998). The urgency of this review was perhaps different in subjects such as History and Mathematics, but important in all learning areas. This process resulted in the release of 'the interim core syllabi' for each school subject.

In March 1997, the Minister of Education officially launched its most ambitious project for educational reform, Curriculum 2005 (C2005), with an underlying philosophy of outcomes-based, learner-centered education. This resulted in profound shifts in how curriculum and teaching were to be understood, in all learning areas, including science. Barely two years later the same government (albeit under a new Minister of Education) called for a "streamlining" of C2005. This heralded further changes in the curriculum (as well as the conceptual knowledge) and the conception of scientific literacy.

In 2001, the Draft National Curriculum Statements for each learning area (a "streamlined" version of C2005) was launched for discussion and implementation and to be implemented in selected pilot schools in 2002. Given the sheer scale and complexity of the original C2005 most teachers were still grappling with the implementation in their classrooms (Taylor & Vinjevold, 1999; Jansen, & Christie 1999; Malcolm, 2001). In fact, the original C2005 had not yet been "phased-in" to all compulsory school grades (1-9) as originally envisioned — a process to be completed by the year 2005. Yet, in midstream, a new or "thin" version of the curriculum was launched which is substantially different from its relative curriculum 2005 of 1997. What kinds of science knowledge now dominate the science curriculum arena and how has the in conception of scientific literacy shifted?

It is against this background that this study intends to examine the policy shifts in the conception of scientific literacy that have taken place in the development of the Natural Science curriculum. Thus the study is located in **research of the curriculum policymaking** process and against different and often competing choices in the selection of conceptual knowledge and in the conception of scientific literacy. The research study will address one critical research question:

What are the theoretical, methodological and contextual constructs that frame the conception of scientific literacy in the Natural Science Curriculum?

I will focus on four periods under review in the development of the Natural Science Curriculum (GET phase) as they present uniquely different influences of reform and have impacted on the content of science in different ways. These phases are pre-1994 (before South Africa's first democratic elections where the control of education was under nineteen different departments of education each with its own syllabus for Natural Science – then called General Science); 1994 (development of the interim core syllabus –

a common syllabus to be used by all the different ex-departments of education); 1997 (the release of the common C2005 based on the philosophy of outcomes-based education) and its review in 2000; and the development of the National Curriculum Statement (published in draft in 2001, and significantly revised for final release in 2002). Each of these periods has been signaled by unique shifts in the rationale for reform, each period a response to a 'new problem'. My empirical focus will be on the latter two phases, because of they ways in which they express (or not) the vision and processes of the new democracy.

1.2 Theoretical Portrait

My comments in the last section hint at a theoretical landscape I will be exploring more deeply. Drawing heavily from the domain of policymaking and the policy process, I have chosen the constructs of archaeology and ideology and emanating from the data the constructs of governmentality, professionalisation and inclusivity. What follows is a brief introduction to these constructs as they permeate all chapters, but each construct is later developed more fully in different chapters of this thesis.

Archaeology

Archaeology is what Mahon (1992) has called the investigation of the "historical *a priori*". Policy archaeology investigates the constitutive grid of conditions, assumptions, and forces that makes the emergence of a social problem possible. Scheurich (1997) has written an instructive account on this method and its relevance to policy analysis. This method is derived from his interactions with the early works of Foucault (1972, 1973, 1979 and 1988) and three of Scheurich's articles, published in 1991. He divides this methodology into four arenas of study or focus:

Arena I: The education/social problem arena: the study of the social construction of specific education and social problems.

Arena II: The social regularities arena: the identification of the network of social regularities across education and social problems.

Arena III: The policy solution arena: the study of the social construction of the range of acceptable policy solutions.

Arena IV: The policy studies arena: the study of the social functions of policy studies itself.

In Chapter 3, I provide a detailed elaboration of, and justification for, this theoretical construct, and use these constructs to gain insight into the empirical data in Chapter 6.

Ideology

The concept of 'ideology' lends itself towards a philosophical and sociological interpretation of science education's aims, contexts and possible effects. The former two are particularly significant in this study. The purpose of philosophy in an educational context is exemplified by Carson (1998), in his article on science and the ideals of liberal education, which is of particular interest to the ideology-in-science-education debate:

> *Philosophy provides a kind of meta-analysis of the public debates over education, examining issues such as what ought to be taught, how it should be taught and why it should be taught. Philosophy organises these and other aspects of the discourse within a larger framework of conventional philosophical topics. . . . What is the ultimate nature of reality? What is knowledge and how do (or can) we acquire it? What is the relationship between knowledge and the world that it is supposed to represent? What makes life meaningful? How should we act? What is democracy? What is the relationship between education and democracy? Who in society is capable of being educated? What is the nature of humanity? What are the goals of schooling? (Carson, 1998:1001).*

Ideologies have impacts: they structure perceptions, legitimate and promote patterns of action, worldviews and values (Fourez, 1988), they are demonstrated in behaviour or conversation (Cross, 1997), they can influence people's worldview, they can regulate a discourse, what is said and the manner in which it is said, and influence interpretation of utterances (Knain, 2001). Ideology links with the practices, beliefs and rationality of government so that the interests of archaeology here would be to excavate various ideologies and uncover interests at work. The construct of ideology is developed in Chapter 2 and how it is manifested in the development of South Africa's science curriculum policies is explored in Chapter 5.

Governmentality

Foucault's ideas on governmentality have had limited penetration in South Africa, where the dominant approaches to policy analysis and critique since the transition have been structuralist and empirical-rational (Tickly, 2003). Foucault (1991) uses the term 'governmentality' in two main ways (Dean 1999). The first is in terms of a general approach towards thinking about the state. Rather than seeking to deduce an essential set of characteristics, essence or *a priori* interests that 'define' the role of the state (as liberal and Marxist accounts attempt to do), he sees the changing nature of the state as being a function of changing rationalities of government. In this view, governmentality can be considered as the art of government, a way of thinking about the practice of government (who can govern, what governing is, what or who is governed) (Gordon 1991). The art of government is often taken for granted by its practitioners in that it draws on ideas, theories, philosophies, and forms of knowledge about governing that are culturally embedded. In contemporary liberal societies, these forms of knowledge derive from the human sciences, such as economics, politics, psychology, sociology and education. Governmentality for Foucault also has a more specific meaning as a way of marking the emergence of distinctly new forms of thinking about and exercising power in certain societies. Essentially governmentality is about covert beliefs, practices and rationality of government. I explore this concept further in chapter 7 and the concept permeates other chapters of the thesis.

Professionalization

Professionalization works closely in tandem with governmentality. Professionalization is a proliferation of professions to treat and manage the citizenry i.e., produce disciplined, productive citizens. The larger implications of this goal are not evident even to the professionals themselves. Like government agents, professionals operate with the best of intentions; indeed good intentions are an important facet of their professional socialization. Consequently, while professionals function within a mindset that legitimizes the need for and value of their therapeutic, transformational or management theories, the theories are ideologies, the regulative purpose of which is to fashion productive citizens according to the norms of the current social order, i.e., to normalize citizens (Scheurich, 1997). Productive citizens continually relearn 'right behavior' by the public display of 'wrong behavior', especially through the social process of identifying social problems, problem groups, and policy solutions. The labeling of problem groups by social agents - particularly by socially legitimated social agents such as professionals) disciplines citizens by defining what a proper productive citizen is and by reaffirming the productive citizens' goodness or correctness. Popkewitz(1996) notes that the modernization inscribed in professionalizationjoins political rationalities with the production of the disciplined and self-reflective individual. Educational practices – among a multitude of practices associated with the emergence of modernity – have played a central role in the professionalization and bureaucratization of western society and have had a direct impact on all sections of society. Professionalization within the field of science education is particularly significant for this study. It emerged from the data, and is explored at a first level of analysis in Chapter 5 and in-depth in Chapter 7.

Inclusivity

Apartheid education was characterized by the use of the curriculum to promote social inequality, racial segregation, and differentiation on the basis of perceptions of abilities (NEPI, 1993). The so-called Bantu Education system of the past was premised on dividing learners along racial lines, and systematically under-resourcing the majority black population. It was underpinned by a curriculum riddled with racism and sexism and designed to keep people in their place. OBE initiatives had to be locally legitimated by emphasizing redistribution, and addressing equity and redress. They promised a dramatic departure from the former apartheid system and a change for the better. A priority for the first democratic government was curriculum reform. South Africa needed curricula that would address, amongst others, the following: (i) values to enhance democracy, human rights and non-racialism; (ii) the needs of a rapidly changing labour market, with increased emphasis on marketable skills science and technology; (iii) moving away from highly authoritarian methodologies towards learner-centred methods, with the aim of developing the full potential of the learner and encouraging a more critical and informed citizenry. At the same time, new government leaders had to signal reforms that were in line with 'world class standards' (Spreen, 2001). Competing demands and alternative solutions required democratic forums to validate the content and direction of OBE, including the science curriculum. Hence, while OBE language at the national policy level tended to be driven by economic concerns, when it reached the classroom level it was about equity, access and redress (Spreen, 2001). The construct of inclusivity is significant for this study as it represented an agenda of the government during the two reform periods of the study. Inclusivity also claims a particular place in this thesis because of the critical research position adopted. I will explore this construct fully in Chapter 8.

1.3. Context of Curriculum Reform in South Africa

1.3.1. Introduction: the big picture

The 1994 elections brought new possibilities, opportunities and expectations for South Africa: a reentry into the global economy; industry reforms in the light of the declining worth of primary industries in favour of 'value added' production; skills, efficiency and imagination; social transformation (amidst social problems of inequity, infrastructure, fear of instability, health etc.); reentry into the political process for the majority of South Africans; and a baggage of financial problems (government debt, low economic growth and consumer confidence). Curriculum reform was seen as a major vehicle for change, driven by the vision of lifelong learning and credentials, one education system for all South Africans, one set of 'outcomes'(DOE, 1995).

1.3.2 Curriculum Development – pre 1994

Under apartheid, the curriculum handed to teachers for implementation was generally experienced as prescriptive, content-heavy, detailed and authoritarian, with little space for teacher initiative (Jansen, 1999b). The teaching-learning process was characterized by learner passivity, rote learning, rigidity of syllabus, and chalk-and-talk presentations. The content in this era was drawn mainly from textbooks that originated in European/Western frameworks. Christie (1997, 112) characterizes this aptly as a 'relatively low participation, high selection system, of comparatively poor quality for the majority of students." Curricula had little relevance to the lives and aspirations of learners, especially Blacks in rural and township communities (Metcalfe, 1997: 15). Failure and drop out rates were high, especially in disadvantaged schools. Moreover, the system accounted for a pervasive lack of critical and creative thinking among school-leavers (Motala, 1995).

1.3.3 Curriculum Development: 1990-1994

The period from February 1990 (the release of Nelson Mandela[1] and the un-banning of liberation movements) through to April 1994 (the first national democratic elections in South Africa) was a critical period in the transition from apartheid (Jansen, 1999a).
In this period, a number of negotiating forums were established to guide the changes. Issues like People's education, multiculturalism, poverty and inequity, globalization, etc., urged rethinking of the philosophy and content of curriculum policy. Strategically, it was necessary to take action before the new government was in place. Once such forum, was the National Education and Training Forum (NETF) which was formed in late 1992. This forum drew from a broad spectrum of stakeholders, including the apartheid government and extra-parliamentary organizations. In August 1994 the South African Minister of Education, Sibusiso Bengu, released a series of newspaper advertisements calling for 'public comment on essential alterations to school syllabuses' (Daily News, 4 August 1994)[2]. This set in motion the National Syllabus Revision Process. Earlier, an active sub-committee of the NETF, the Curriculum Technical Sub-Committee (CTSC; then chaired by Mary Metcalfe) deliberated on the establishment of a long-term curriculum framework. Since such a framework would take at least two to three years to establish, the CTSC decided to consider short-term syllabus revisions as one means for intervening in the education crisis. The NETF approached the (apartheid) Ministry of Education requesting political, logistical and financial support for a national venture that would involve a review of more than 100 school syllabuses. After delays that lasted into the post-election period, the new Minister of Education assumed political responsibility for

[1] Nelson Mandela was the first president of a democratic South Africa.
[2] The Daily News is a National South African publication.

the syllabus reform (Jansen, 1999a). A three-member national co-ordinating committee was formed to establish 11 'field' committees (e.g. mathematics, natural sciences, life orientation, etc.) and three 'phase' committees (junior primary, senior primary and secondary) with more than 30 subject committees. The committees were to address: (i) 'the factual incorrectness of subject matter' resulting from socio-political changes and new developments in the field of study; (ii) 'content which does not reflect sensitivity to the perspectives of different groups in South Africa'; and (iii) 'the possible consolidation of syllabuses', given that different racial departments had operated different syllabuses for the same school subjects (Jansen, 1999a).

Jansen (1999a) describes the National Syllabus Revision Process as an act of "compensatory legitimation" (Weiler, 1983) by a state that was vulnerable in its most volatile sector, namely education, immediately after the election. Jansen (1999a) states that early meetings of the committees were characterized by intense struggles for voice, representation and meaning around the ministerial brief. In the Science Committee for example, a large proportion of time was absorbed in the discussions as to whether "the Creator clause" in these syllabuses should be removed (the contest was real!). All science syllabuses under apartheid had declared the objective that the child become aware of the majesty of creation through his acquaintance with the wonder and order of Creation and in this way develop a sense of awe and reverence for the Creator.

According to the field committee report to the Department:

> *...... all agreed that the removal of the clause was merely symbolic as it did not in fact impinge on what went on in science classrooms* (Report of Field Committee for Natural Science, 1994 cited in Jansen, 1999a).

In the end, the syllabus reviews produced three main, and fairly minor, changes in content: (i) <u>non - change</u> i.e., some syllabuses remained completely unchanged e.g., African languages, "because the existing syllabuses are so flawed that that tampering would be futile"; (ii) <u>editorial - adjustments</u> i.e., some syllabuses simply added an introductory overview e.g., English, for which a "communicative approach" was encouraged; (iii) topical-reshuffling i.e., some syllabuses added new topics and scaled down others e.g., History that de-emphasized European History and expanded "African Nationalism" (Jansen 1999a).

Jansen (1999a) draws four conclusions about the syllabus revision process through the lens of political transition and the construct of 'compensatory legitimation'. Firstly, the syllabus revision process had to be understood in the context of the constitutional and bureaucratic constraints of political transition under Government of National Unity. These constraints were powerfully felt in the Ministry of Education. Secondly, the syllabus revision process emerged in the context of weak and vulnerable political leadership in the Ministry of Education. That is, a leadership which failed to translate political constraints into strategic opportunities for educational transformation. Thirdly, the syllabus revision was propelled by mounting pressure on the Ministry of Education from the media, allied ANC constituencies, and the broad public for intervention in the education crisis. In order to compensate for a lack of visible, durable and long-term changes in the education sector, the minimalist syllabus reform process provided the Minister (and government) with important political breathing space in the early days of transition. Fourthly, the syllabus revision process and brief faced only weak political challenges from the educational community. In fact, the participation of most teacher bodies – from across the political spectrum –compensated for the loss of legitimacy suffered by the Ministry of Education in the latter half of 1994, and its predecessors under the apartheid government (Jansen, 1999a). The consequences of review for classrooms were a flurry of syllabi sent to schools called 'interim revised syllabi'. Several of the syllabuses reflected the existing House of Assembly[3] syllabuses thereby reinforcing and legitimizing the white education model of curriculum content and assessment. In other cases,

> *.....the new syllabuses represented a fusion of the core curricula of the old ethnic departments which in itself is possibly the worst basis from which to introduce any progressive syllabus. Thus the point of departure (i.e., the brief) already determined the outcome and defeated the purpose of presenting improved syllabuses* (NETF, 1995)

---

[3] The House of Assembly was a designated ethnic education department for predominantly white learners.

1.3.4 Outcomes based education and Curriculum 2005

Meanwhile, in 1992, the National Education Coordinating Committee (NECC) initiated the NEPI to develop policy options for the broad democratic movement. One of the key groups in the NECC was the curriculum group, which produced a foundational document on which much of the existing 1998 curriculum policy is based (NECC, 1992). NEPI provided a framework for democratic education policy after apartheid that emphasized non-racism, non-sexism, democracy, equality and redress as the platform for post-apartheid education policy and curriculum. The NEPI work, completed in 1992/93, made no reference whatsoever to OBE and only broad suggestions about a coordinated system for education and training (Jansen, 1999a). However, many of the debates revolved around vocational and competency based education, critical outcomes for peoples' education, and the tensions between global and local orientations.

Various other organizations (including the United States Agency for International Development or USAID, NGOs and interests groups such as the apartheid state's curriculum initiative CUMSA – A New Curriculum Model for South Africa) were actively framing curriculum reforms after 1990. The most important proved to be the National Training Board (NTB), who argued for what later became known as OBE. The NTB produced a significant policy document at the time, the National Training Strategy Initiative (NTSI). While the primary focus of this strategy was the labour and training sector, its proposals for an integrated approach to education and training bound the education sector, including schools, into this way of thinking. Given that debates within the Department of Labour had progressed quite considerably as a consequence of its developmental work within COSATU and the NTB (Jansen, 1999a), the tension between 'people's education' and redress on the one hand, and workplace skills and economic development on the other was minimally addressed. There was very little integration or interrogation of educational ideas into this labour-driven debate, at least from people working within schools (Jansen, 1999a).

The conception of OBE can be mapped instead to early competency debates in Australia, New Zealand, Scotland and Canada, and also from William Spady's work in the United States (Spreen, 2001, Jansen, 1998). In 1995, the *White Paper on Education and Training of* 1995, produced by the Ministry of Education reflected the key ideas of integration (of education and training, theory and practice) and competency as elements of a system wide education restructuring ambition. Shortly afterwards, a series of curriculum policy documents in the form of 'discussion documents' was published through the DOE, elaborating the integrationist and competency discourses but still with little reference to OBE.

Then almost without warning, in late 1996, a key document emerged, spelling out the proposals for OBE and the weakly coupled C2005. The introduction of OBE as a curriculum policy was consummated in a dramatic public relations display in March 1997 when the Minister of Education officially launched C2005 in Cape Town. On this occasion it was announced that OBE would be introduced into Grade 1 and 7 classrooms in January 1998, a proposal subsequently limited to Grade 1. In the wake of this announcement, a series of popular documents emerged to explain OBE to teachers, followed by one-week information sessions (billed as 'training') for many Grade 1 teachers, as well as implementation in a selection of pilot schools in each of the nine provinces (Jansen, 1999b). The official curriculum documents defined rapid shifts in content in order to achieve the critical outcomes specified by the policy documents. In terms of the design features of OBE, policymakers borrowed from the outcomes based approach underway at the time in Australia, and from the work of William Spady in the United States. For features of the curriculum framework and the organization of learning areas, policy makers looked to Canada (specifically the OBE-related initiative in Ontario). For an accreditation scheme and transferability of credits they looked to Scotland (SCOVOTECH) and for a Qualification Framework (accountability and assessment structures) policy makers drew heavily on the New Zealand qualification frameworks and to a lesser extent the Scottish NQVs (Spreen, 2001).

How is the rationale for OBE articulated in the formal curriculum documents?

The *National Curriculum Framework* document of 1995 provides the following rationale for OBE:

> *A prosperous, truly united, democratic and internationally competitive country with literate, creative and critical citizens leading productive, self-fulfilled lives in a country free of violence, discrimination and prejudice* (Department of Education, 1995).

Malcolm (2001) provides an elaboration of this rationale, based on existing beliefs about teaching and learning from across South Africa's social and cultural landscape: (i) *Social Arguments:* to improve equity and distribution of opportunities in multi-cultural and economically diverse nations, build democratic participation, cultural expression and national identity, South Africa gave formal emphasis to learner centered education; (ii) *Economic Arguments:* the shift from primary production to value-added production required a shift to new outcomes of education, emphasizing competence, creativity, self management and team work rather than knowledge acquisition that dominated in the past; (iii) *The Educational Context:* In South Africa, OBE was used to loosen up a system that was seen to be too rigid (with syllabuses, textbooks, examination and inspectors) and too divided (legacy of apartheid). Furthermore, the South African system, was one in which roles were distinct and narrowly defined, to fit the bureaucratic structures and management. Principals, teachers, and learners worked more as technicians than critical professionals. OBE with its devolution of curriculum and management could help teachers at school level to design curriculum, not only to suit their learners, but also to suit local resources; (iv) *International Trends:* OBE is a management technique that can help with learner-centered education in a multicultural society, improve effectiveness and efficiency in learning and provide for accountability of teachers, schools, and whole systems; (v) *Educational Training and Life-long Learning:* South Africa in the 90's was caught unprepared for the declining value of primary commodities in international trade and the need for value-added production. This called for rapid restructuring of industries, workers, education and training. The language and basic discourse of unit standards and criterion-based assessment is different in the National Qualifications Framework (NQF) from the traditions of South African schools and universities; (vi) *The Political Context:* The development of OBE saw major battles between powerful interests groups; centralization versus de-centralization of curriculum control, traditional content versus competences as outcomes, behaviorism versus constructivism, the definitions and epistemologies of the learning areas, and the desirability and the wording of the outcomes themselves.

Establishing a shared rhetoric around OBE was difficult. Jansen (1999b) suggests that OBE did not emerge as a coherent and comprehensive curriculum reform in South Africa; its origins lie in a number of disparate influences, both internal (e.g., competency debates in labour) and external (e.g., the Spady version of OBE in the United States); both historical (the apartheid legacy) and contemporary (managing the contradictory claims of reconstruction, redistribution and reconciliation); both educational (performance- based learning) and economic (globalization pressures to participate efficiently in competitive economies). Politics remains a primary force in shaping the timing, focus and **content** of curriculum policy in a democratic state. Indeed, the sudden introduction of OBE in South Africa was primarily a response to a long period of non-intervention (1994-1997) in the apartheid curriculum, apart from superficial attempts described earlier to cleanse the apartheid syllabuses (14-15). The outcomes of schooling are not simply a set of academic and practical skills, but social and political. Curriculum reform can confirm power relationships, knowledge selection and structures in the society or it can challenge them. In all countries where it has been introduced, OBE has sought to challenge the *status quo*.

Findings from research and the C2005 review

As many critics had warned, C2005 soon ran into a myriad of difficulties that threatened the survival of the new curriculum (Jansen, 1999c; Tema, 1997). Teachers complained of frustration, disillusionment, poor training provisions, the complexity of the language and design of the new curriculum, lack of support, and the general haste of implementation (Taylor & Vinjevold, 1999; Chisholm, 2000; Marnewick & Spreen, 1999; Jansen &

Christie, 1999). At the beginning of 2000, when it became clear that the implementation of C2005 was not going well, the new Minister of Education, Professor Kader Asmal, ordered a review of the C2005. He was very clear that the underpinning OBE principles were not the subject of scrutiny. After a short 3-month process of reviewing submissions and documents; and site visits and interviews with key role-players, the Chisholm Committee published its findings. It found that the implementation of C2005 was compromised by its complex structure (coherence and details were not clear) and design, tight time frames, lack of resources, a weak model of teacher training, insufficient learning support materials and poor departmental support for teachers. (Chisholm, 2000: 27). The review team recommended that Curriculum 2005 be streamlined, phased out and 'strengthened' with a revised version to be called the National Curriculum Statement. The proposed streamlining included reducing the number of Learning Areas from 8 to 6 and discarding some of the problematic design features of C2005 such as range statements, performance indicators and phase organizers. It recommended that the terminology of the NCS be made more accessible and clear and that a more flexible time frame for implementation be scheduled (Department. of Education, 2001: 27). The parallel shifts in focus of government from RDP to GEAR, raised the idea of defined 'standards' and a new emphasis on 'high knowledge and high skills' shifted the curriculum subtly from the socially critical position to the technical skills position.

Consequently the education ministry created a Ministerial Project Committee to design a National Curriculum Statement (NCS later called the Revised National Curriculun Statements-RNCS) within the context of the review recommendations. The resulting policy document was released at the end of July 2001, signaling the start of a second wave of curriculum change in South Africa. At the ministerial launch of the NCS on the 31st July 2001, it was announced that actual implementation would only commence in 2004, but groundwork and pre-implementation activities would be done in 2002 and 2003. These included piloting of the NCS, teacher orientation and training and the development of learning programmes.

1.3.5 Development of the National Curriculum Statement (NCS). A second go!

The aim of the NCS is stated as being to 'build on the visions and values of C2005' to promote 'democratic values' and to prioritize 'justice and social citizenship'. The key change features evident in the *Draft Revised National Curriculum* (Department of Education 2001a: 1- 40):

- The NCS consists of an Overview, 8 Learning Area Statements (including Natural Science) and a Qualifications Framework for the GETC for compulsory schooling. As in C2005, the NCS is underpinned by outcomes-based, learner-centered education, and a set of 'critical and developmental outcomes' (key competences) that are common to all curriculum, at all levels of education, via the National Qualifications Framework.
- Each of the 8 Learning Areas is characterised by a Learning Area Statement that defines the learning area, and describes what learners are expected to achieve in each grade, in terms of a small number of Learning Outcomes, and a series of Assessment Standards for each Learning Outcome.
- Each province or school is expected to formulate their locally contextualised Learning Programmes from the NCS.

The terminology and language of the NCS is much simpler. There is a better balance between integration (across Learning Outcomes and Learning Areas) and progression (in the learning outcomes). In each grade, the Assessment Standards detail progressively deeper knowledge and skills. The implementation schedule is more relaxed, with implementation of the NCS in Grades R-3 scheduled for 2004.

The 'Road Map' (Department of Education, 2001b) for the Development of the NCS provided the following principles upon which the NCS was to be based:

- Be a 'high knowledge and high skills' curriculum.
- Promote social justice, equity and development.
- Ensure a balance of conceptual progression and integration.

- Provide clear guidelines to teachers as to what is to be taught and the level at which it is to be taught and assessed.
- Foreground the following as foundations for further learning: comprehensive reading and writing skills, mathematical skills and core concepts in the social and natural sciences.

In Chapters 5 and 6 I look closely at the curriculum policy documents for ideological shifts in the conception of scientific literacy.

1.4 An Overview of the Chapters

At its broadest and most general level, this is a study of the policymaking process in science education and how this has shaped the conception of scientific literacy.

Chapter 1 introduces the argument for the study and develops the main research question: *What are the theoretical, methodological and contextual constructs that frame the agenda for the inclusion/exclusion of particular kinds of scientific knowledge in the Natural Science Curriculum?* It provides a rationale for the study and describes the contextual background for why such a question is possible and necessary in South Africa at the present time. It also locates the context for reform in each of the four periods of the study. This part of the chapter relies heavily on the available literature and studies done in these periods. These reform periods are reflected upon against the backdrop of discourses that inform both the selection of conceptual knowledge and those discourses that inform/shape the conception of scientific literacy. This part of the chapter sets the stage for exploring how policy writers have participated in policy formation in different ways and maps the history of these changing forms of participation. It does this by revealing aspects of the context in which successive policies have been formed.

Chapter 2 sketches the emergence of scientific literacy and reform movements in that arena. It frames both the research design and analysis and makes explicit the assumptions on which the research rests.

Chapter 3 seeks and puts forward a research methodology appropriate to a critical policy analysis. The nature of the research question calls for a post structural analysis of policy. The study offers a theory of methodology in analyzing the policy writing process. The methodology relies heavily on policy historiography, policy genealogy and policy archaeology in the analysis of the policy process. Throughout I offer reflections on the research process and explore the value of critical policy analysis for the policy writing process.

Chapter 4 This chapter serves to illustrate my role as researcher as well as outlines the detailed research methodology that was used to answer the critical research question of this study. This study entailed probing who has been involved in the policy writing process and which organizations they represent; policy writers' perceptions of the policy making and policy writing processes; and the science conceptual knowledge that policy writers deem valuable to be included in the curriculum policy documents. I also conducted an in-depth analysis of key policy documents to trace the ideological shifts in the conception of scientific literacy. The two key sources of data were policy writers and policy documents.

Chapter 5 unmasks the narrative and looks at shifting ideologies in the conception of scientific literacy. It begins a first level of analysis, what may be called a "grassroots" analysis and lays the foundation for the development of policy lessons in Chapter 9. It relies mainly on policy historiography as an analytical tool and develops the construct of professionalization.

Chapter 6 excavates the policy process and explores the rules of the policy game primarily through the epistemological stance of policy archaeology and policy genealogy. My intention here is to dig deeper and understand the rules of the game of how the policy came to be, to unearth how the details of the particular structure has been resolved. I will explore three broad frames of reference to excavate the policy process: the people involved; the structures that constrained or facilitated the process; and the form of the policy documents. In particular, I would be exploring: who were the policy actors and how were they chosen; what shapes policy choices- what happens in the policy environment that led to choices made; how did the policy problem emerge and what regularities made it possible for this problem to emerge and; what were the conditions that regulated patterns of interaction of those involved? It provides the data where the construct of governmentality emerged.

Chapter 7 develops a second level of analysis where I will delineate the two regularities that I have identified in Chapter six and discuss how they are necessary for the emergence of the policy problem (the second arena of policy archaeology, how they shape the social construction of the problem-curriculum reform (the first arena of policy archaeology), and examine how these regularities constitute and shape the range of policy solutions (the third arena of policy archaeology). This analysis draws heavily from the work of Scheurich (1997) on policy archaeology. I posit that these regularities are necessary for the social construction of the policy problem in both the C2005 and the RNCS processes. These regularities intersect in a complex, grid-like fashion on the policy-problem axis. These intersecting regularities makes it possible for the policy problem to emerge as a problem, constructs the problem, and constitutes the problem as an 'object' of social visibility.

Chapter 8 develops the argument of how/ not the policy process and the resulting documents express and further social justice, democracy, social critique and empowerment.

Chapter 9 is the concluding chapter of the dissertation and provides policy lessons and recommendations for the South African context in a new democracy.

1.5. CONCLUSION

The central purpose of this chapter is to lay the 'context' for the study and establishing why it is worth doing. I have provided an outline of the pre 1994 situation as my research picks up the story from there. Although the focus of this study is science education, this research is set within the domain of broader policy changes within education. I have introduced the argument for this study and the rationale behind such questions. Recall, the purpose of the study is to excavate the policy process and how policy writers have conceived the notion of scientific literacy. Embedded in this purpose is how the selection of science conceptual knowledge was made. This purpose needs to be understood against the complexity involved in (a) a developing country with extraordinary inequities and poor economic performance and, (b) post apartheid transformation and its urgency, where many things were happening at once.

Having introduced the study in Chapter 1, Chapter 2 will sketch in more detail the theoretical landscape of the conception of scientific literacy in which part of this research rests. In Chapter 3 the policy research methodology employed is described, but in addition I raise some concerns for this relatively under-researched approach particularly in analyzing policy in South Africa. Chapter 4 provides the research methodology adopted in this study. In Chapter 5 I lay out the ideological shifts in the conception of scientific literacy. The first level is analysis is completed in Chapter 6 where I present an excavation of the policy process. This chapter delineates two regularities that I explore in Chapters 7 and 8. In Chapter 9, I present a third level of analysis as emerging propositions are used to forward recommendations and policy lessons for a new democracy.

Chapter 2

Scientific Literacy

As a Goal for Science Education: An Ideological Orientation

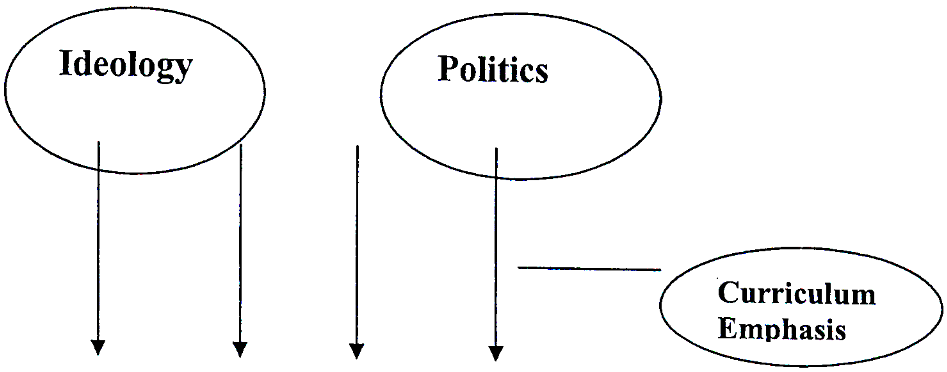
> *Let me take my cue from Shakespeare once more. 'Nay come', he makes Hamlet say, 'let's go together'. I join him there and thus I view educational reform in the way I view scientific literacy: as a collective phenomenon. Science education reform must become a collective effort where teachers and researchers join their hands to change current conditions in and through daily praxis* (Roth and Tobin 2002).

2.1 Introduction

South Africa's C2005 (in 1997), NCS (in 2001) and RNCS (in 2002), like science education policies in many countries, claim as their goal the development of scientific literacy. Thus understanding this concept and debates about its meaning are vital to understanding the development of the policies. In this chapter, I explore the concept, linking it especially to ideology, and different views of the purposes of science education. While the focus of this chapter is ideology, the discussion is also about politics. Scientific literacy is a contested idea, a fact often lost when it is proposed glibly as the goal of science education. This chapter will contain a reflection on the politics of scientific literacy as well as ideology.

The use of the concept of 'ideology' lends itself towards a philosophical and sociological interpretation of science education's aims, contexts and possible effects. As such ideologies have impacts: they structure perceptions; legitimate and promote patterns of action, worldviews and values (Fourez, 1988); ideologies are demonstrated in behaviour or conversation (Cross, 1997); they can influence people's worldview; they can regulate or influence a discourse; what is said and the manner in which it is said; and influence interpretation of utterances (Knain, 2001). In his discourse analysis of textbooks Knain (2001) used the framework of the functional grammar of Halliday (1999) combined by Robert's (1983) "curriculum emphases" theory (see section 2.4). Ideologies are inferred by analyzing the text in terms of words and grammar and comparing it with the situational and cultural context. Knain's (2001) analysis based on some non-exclusive "ideological dimensions" helps to ask fundamental questions about *science*: What's the nature of science and epistemology? How is science connected to culture and human activity? Is knowledge sought for its own sake or for practical purposes? What about science in various institutional settings? What is the relationship between science and technology? What is the potential of science for both causing and solving problems? What is the ontology of nature and how to act morally towards nature? Is science compatible with wonder, mystery and aesthetics? What motivates science? Why learn science anyway (Robert's, 1983- curriculum emphases)?

A summary of the interpretative tools drawn from this chapter is illustrated in the Figure below:



SCIENTIFIC LITERACY

The chapter is organized as follows:

In **Section 1,** I present the evolution of scientific literacy as a goal for science education. In this section I provide various notions of science literacy and link them to particular periods of reform, I explore the evolving nature of scientific literacy and present a particular construction of scientific literacy that could be used as an interpretive tool. I also provide a reflection on the hegemonic conception of scientific literacy.

Section 2 explores the philosophical and sociological interpretation of science education's aims, context and possible effects through three dimensions of ideology: epistemology, metaphysics-ontology and axiology (adapted from Sather, 2003).

In **Section 3,** I draw from Roberts 1981 'curriculum emphasis' (primarily about purposes of science education) to add to the toolbox of constructs that assist in the interpretation and analysis of the curriculum policy documents.

In the concluding section I emphasize interpretive and analytical constructs that I will later use to interrogate data from interviews, questionnaires and the curriculum policy documents.

2.2 The concept of Scientific Literacy

The term "scientific literacy" was first coined in the late 1950s, and most probably appeared in print for the first time when Hurd (1958) used it in a publication entitled *Science Literacy: Its Meaning for American Schools* (DeBoer, 1991; Roberts, 1983). Nevertheless, interest in, and concerns about elements of the concept of scientific literacy (i.e., the idea that everyone should have some knowledge of science) go back at least to the beginning of this century (Shamos, 1995). Consequently, scientific literacy has become an internationally well-recognized slogan, buzzword, catchphrase, and contemporary educational goal. Scientific literacy "stands for what the general public ought to know about science" (Durant, 1993: 129), and "commonly implies an appreciation of the nature, aims, and general limitations of science, coupled with some understanding of the more important scientific ideas" (Jenkins, 1994: 5345). The term is usually regarded as being synonymous with "public understanding of science," and while "scientific literacy" is used in the United States, the former phrase is more commonly used in Britain, with "la culture scientifique" being used in France (Durant, 1993). Science educators generally agree that scientific literacy should be an important outcome of schooling. But in essence it is a statement of the science learning that is of most worth, and hence is always open to debate: there is no precise or agreed upon definition (DeBoer, 2000).

One criticism of the concept of scientific literacy as defined in recent reform efforts in the USA (AAAS, 1989; NRC, 1996) is that it does not properly anticipate diverse groups of people who put science to use in broader, different, or socially responsible ways (Eisenhart, *et al,* 1996). This criticism is especially relevant in a developing country such as South Africa. Do we teach biology, chemistry, physics, mathematics, or do we teach young people to cope with their own world? Science courses are often a means of pushing students into the world of scientists rather than a way of helping them cope with their own life-worlds (Fourez, 1997). The 1990s saw an intensive debate about scientific literacy inspired by concerns about the educational demands of the 21st century (DeBoer, 2000; Groaber & Bolte, 1997). Later in the 1990s, these discussions were further fuelled by the results of the Third International Mathematics and Science Studies (TIMSS) project that uncovered striking deficiencies in scientific literacy (as defined by the TIMSS tests) in many countries. More recently, Programme for International Student Assessment (PISA) (OECD/PISA, 1999) also showed that students' performance in many countries (using a slightly different concept of scientific literacy) was less than expected. In a number of countries, including South Africa, the disappointing results of students on TIMSS and/or PISA studies have alarmed a broader public, as well as politicians and school administrators, who demand that school science instruction become more effective. These results provided another impetus for discussion on scientific literacy concepts and on attempts to improve science teaching and learning. Despite tremendous efforts since the 1960s, some argue that educational reforms have for the most part failed to produce scientifically literate citizens, and this fact alone requires a review of the definition (Shamos, 1995).

The complexity of current conceptions is indicated by proposals such as the one by Driver and Osborne (1998), who offer four arguments for the need for scientific literacy: (i) the economic argument–modern societies need scientifically- and technologically-literate work forces to maintain their competencies; (ii) the utility argument–individuals need some basic understanding of conceptual change in science and technology to function effectively as individuals and consumers; (iii) the cultural argument–science is a great human achievement and it is a major contributor to all cultures and; (iv) the democratic argument–citizens need to be able to reach an informed view on matters of science-related public policies in order to participate in discussions and decision-making. Taken together, these 'visions' are ambitious. If the goals are to be achieved at the high levels implied (Bybee, 1997) complex curriculum designs, teaching and learning processes are required and these in turn require effective systems of support.

Beeth *et al* (2003), still largely within the context of classrooms (as against whole systems of education) argue the needs for: (1) supporting schools and teachers to rethink the representation of science in the curriculum; (2) enlarging teachers' repertoires of tasks, experiments, teaching and learning strategies and resources; (3) promoting strategies and resources that increase students' engagement and interest and; (4) setting constructivist principles into practice. These characteristics imply that teachers are reflective practitioners with a non - transmissive view of teaching and learning and that the students are active, responsible, co-operative and self-reflective learners.

Laugksch (1999) shifts attention from purposes to interest groups that seek to influence the definition of scientific literacy. He identifies four groups:

(i) *science education community*

This group is concerned with the nature (i.e., purpose), performance, and reform of existing educational systems (see, e.g., Champagne & Newell, 1992; Jenkins, 1992; Kyle, 1995a, 1995b). This group is motivated by issues related to (a) the goals of science education; (b) how personal skills, attitudes, and values implied by the goals are successfully incorporated into the science curriculum, and effectively taught by teachers; (c) the quality and nature of resources required to achieve these goals efficiently (e.g., text-books); and (d) appropriate measures of assessment to ascertain to what extent the goals for science education have been met. This group comprises especially science education researchers, curriculum and policy developers, and professional science education associations. It is therefore mainly concerned about the relationship between formal education and scientific literacy, and has tended to focus on secondary education, though it is increasingly concerned with primary and tertiary education.

(ii) *social scientists and public opinion researchers concerned with science and technology policy issues (see, e.g., Miller, 1992).*

This interest group is essentially concerned with the general public's support for science and technology, as well as the public's participation in science and technology policy activities. Pertinent fields of inquiry for this category of researchers, are thus related to the identification of the individual's sources of scientific and technical information; measuring the public's scientific knowledge base and perceptions of the limitations of science; as well as measuring the public's attitude toward science and technology in general and policy issues in particular (see, e.g., National Science Board, 1991, 1993, 1996).

(iii) *sociologists of science and science educators employing a sociological approach to scientific literacy.*

These researchers are concerned with the construction of authority with respect to science (i.e., organizational forms of ownership and control of science), or "knowledge in context" (Wynne, 1991). Fields of inquiry for this category of researchers are related to how individuals in everyday life interpret and negotiate scientific knowledge; how social access, trust, and motivation are linked to public uptake of and support for science; and how ". . . members of the public ... monitor sources of scientific information, judge between them, keep up with shifting scientific understandings, distinguish consensus from isolated scientific opinion, and decide how expert knowledge needs qualifying for use in *their* particular situation" (Wynne, 1991: 117).

(iv) *informal and non-formal science education community (Lucas,1991; Maarschalk, 1988), and those involved in general science communication.*

The combined group consists of those professionals that provide educational and interpretative opportunities for the general public to better familiarize itself with science (see, e.g., Durant, 1992; Quin, 1993), in addition to those who report science as "news" (see, e.g., Nelkin, 1995) and write about science in general (see, e.g., Lewenstein, 1989; McRae, 1993). These professionals include relevant personnel involved in science museums and science centers, botanical gardens and zoos, as well as members of creative teams involved in science exhibitions and science displays. Science journalists and writers, and relevant personnel involved in science radio programs and television shows complete this interest group.

It is clear from the above discussion that scientific literacy means different things to different groups and gains their political support: ideology and politics are inextricably linked. One of the earliest attempts to provide an empirical basis for the definition of scientific literacy was the work of Pella et al (1966). They determined the frequency of occurrence of "referents", that is, themes that were assumed in advance to be related to scientific literacy, in 100 carefully and systematically selected papers published between 1946 and 1964. They concluded that the scientifically literate individual was characterized as one with an understanding of the (a) interrelationships of science and society; (b) ethics that control the scientist in his work; (c) nature of science; (d) difference between science and technology; (e) basic concepts in science; and (f) interrelationships of science and the humanities (Pella et al., 1966).

Showalter (1974) presents a more elaborate definition of scientific literacy through integrating 15 years of relevant literature. His definition consists of seven dimensions. The scientifically literate person: (i) understands the nature of scientific knowledge; (ii) accurately applies appropriate science concepts, principles, laws, and theories in interacting with his universe; (iii) uses processes of science in solving problems, making decisions, and furthering his own understanding of the universe; (iv) interacts with the various aspects of his universe in a way that is consistent with the values that underlie science; (v) understands and appreciates the joint enterprises of science and technology and the interrelationship of these with each and with other aspects of society; (vi) has developed a richer, more satisfying, more exciting view of the universe as a result of his science education and continues to extend this education throughout his life and; (vii) has developed numerous manipulative skills associated with science and technology (Showalter, 1974: 450).

Collectively, these dimensions embrace science processes, skills, values and conceptual knowledge. Shamos (1995) proposed a conception of scientific literacy consisting of three forms, ". . . which build upon one another in degree of sophistication as well as in the chronological development of the science-orientated mind" (p. 87). The first form, "cultural scientific literacy," is that proposed by Hirsch (1987). It is the simplest of the three forms of scientific literacy, and in Shamos's (1995) view represents the level of scientific literacy held by most educated adults who believe they are reasonably literate in science (Shamos, 1995). The second form, "functional scientific literacy," requires that the individual not only commands a scientific vocabulary — a "science lexicon" (p. 88) but can converse, read, and write coherently in a non-technical but meaningful context (Shamos, 1995). Whereas the first form is passive (e.g., recognition of science-based terms used by the media), the second is more active. A functionally scientifically literate individual would thus not only be able to read and comprehend a science-based newspaper article, but would also be able to communicate the substance of that account to a third party (Shamos, 1989). This form of scientific literacy is also described as "science for specific social purposes" (Layton *et al*, 1993). This interpretation of scientific literacy maintains that members of the public are not passive "consumers" of science but that "usable" scientific knowledge needs to be reworked and put into context (Layton et al., 1993). "Scientific knowledge is not received impersonally as the product of disembodied expertise but comes as part of life, among real people with real interests in a real world" (Ziman, 1991:104). How the public perceives and uses scientific knowledge is therefore not only related to the public's understanding of the formal content of scientific knowledge and the methods and processes of science, but also with "the forms of institutional embedding, patronage, organisation and control of scientific knowledge" (Wynne, 1992: 42). According to Miller (1989) scientific literacy depends on the context in which is it intended to operate, and "is inherently relative to the society in which it is used" (p. 4). Given that scientific literacy is a socially defined concept, it follows that the concept differs for different eras in time (e.g., pre- and post-nuclear age), geographical regions (e.g., heavy industry- and agriculture-based local economy), and communities or social conditions (e.g., suburban and informal or high-density housing). A hegemonic, universal conception of scientific literacy therefore has to be deeply questioned.

Shamos's (1995) third form of scientific literacy, "true scientific literacy," is the most difficult to attain, as it involves, in addition to the previous forms, knowing something about the scientific enterprise. Such an individual:

> *is aware of some of the major conceptual schemes (the theories) that form the foundations of science, how they were arrived at, and why they are widely accepted, how science achieves order out of a random universe, and the role of experimentation in science. This individual also appreciates the elements of scientific investigation, the importance of proper questioning, of analytical and deductive reasoning, of logical thought processes, and of reliance upon objective evidence* (Shamos, 1995: 89).

Bybee (1997) proposes four levels of scientific literacy, of which the lowest two are 'nominal scientific literacy', consisting of knowledge of names and terms, and 'functional literacy' which applies to those that can use scientific vocabulary in limited contexts. The third level, Bybee (1997) coins "conceptual and procedural scientific literacy" and the highest level 'multidimensional scientific literacy' which includes understanding the nature of science and of its history and role in culture. Collectively these four levels appear to be elaborations of Shamos's (1995) first and second form of scientific literacy.

Lee and Roth (2001) point out that much of the debate about scientific literacy sees scientific literacy as a property of individuals, to be measured by means of traditional forms of individual assessment. The orientation to individuals and assessment results in focuses on knowledge, facts, and theories that individuals are expected to exhibit:

To acquire information necessary for scientific literacy, individuals must comprehend, interpret, and evaluate information and conclusions based on scientific research (Korpan et al, 1997:51).
It is generally agreed that a science- literate individual possesses a basic vocabulary of scientific concepts and terms, knowledge of the processes of science utilized to test our models of making sense of the world, and an appreciation of the effect of science and technology on society, to a degree sufficient to participate in dealing with the increasingly large number of science-and technology public policy questions we face (Flower, 2000: 38).

In the everyday world of the community, science emerges not as a coherent, objective and unproblematic body of knowledge and practices. Rather, science often turns out to be uncertain and contentious (most obviously in its applications in complex systems), and unable to answer important questions pertaining to the specific (local) issues at hand (Jenkins, 1999). In everyday situations 'citizen-thinking' may offer a more comprehensive and effective basis for action than scientific thinking (Lee and Roth, 2001). They see scientific literacy, not as an individual phenomenon, not something that is owned by (or characterizes) certain individuals, but rather an emergent, collective phenomenon. Such scientific literacy may, for example, emerge when ordinary citizens question a scientist about the methodology he used which turns out to fall short considering the problem at hand. Recognizing this falling-short as a collective achievement is the kind of scientific literacy that Lee and Roth (2001) advocate. This scientific literacy, then, "emerges when scientists, science-related professionals, and people from other walks of life and with different backgrounds engage each other over contentious and personally relevant issues. Thus, everyone (speakers, listeners, moderators) and everything (reports, spatial arrangements, historical context) in the public meeting is part of the appearance of scientific literacy.

A number of writers bring to the fore the issue of language as an integral part of science and science literacy—language is a means of doing science and constructing understandings; language is used to communicate inquiries, procedures, and science understandings and negotiate decisions and actions (Hand *et al*, 2001; Norris &Phillips, 2003). Oral and written language is the symbol system most often used by scientists to interpret, construct, describe, and present science claims and arguments, and it is, in the main, the same language that citizens use (for if it weren't, communication would be impossible). Language shapes science ideas and understanding, and the non -language features of science shape scientific discourse (Locke, 1992). Norris & Phillips (2003) note that fundamentally science literacy involves being fluent in the language, discourse patterns, and communication systems of science, and in the derived sense being knowledgeable, learned, and educated in science. The international science education reforms incorporate both these levels (Hand *et al,* 2001).

Science curriculum policies, through their aims, outcomes and suggested content, provide operational definitions of scientific literacy. From such documents, for example, in the USA, UK and Australia, at the most basic level, scientific literacy rests on understanding key science concepts, usually delineated into the categories of physical, life, earth, and space science (NRC, 1996). Hand-in-hand with conceptual understandings, the policies promote the methods of science, used to conduct investigations, test theories, answer personal questions and judge the answers proffered by others, and can recognize the strengths and limitations of scientific inquiry. Emphasis is given to those concepts (the 'big ideas') and processes (empiricism) that unify science, with some attempt to recognize the interrelationships and interdependencies between science and other disciplines (AAAS, 1993; NRC, 1996). For example, the Natural Science Education Standards (NRC, 1995) lists the following goals for school science: "to educate students who are able to (i) experience the richness and excitement of knowing about and understanding the natural world; (ii) use appropriate scientific processes and principles in making personal decisions; (iii) engage intelligently in public discourse and debate about matters of scientific and technological concern and; (iv) increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person. "These goals define a scientifically literate society. The standards for content define what a scientifically literate person should know, understand, and able to do after 13 years of school science" (NRC, 1995: 13). In the National Science Education Standards, the content standards define scientific literacy.

Project 2061 has similar general goals that address the knowledge, skills and attitudes essential for scientific literacy. According to *Science for All Americans*, a scientifically literate person: (i) has integrated knowledge of different disciplines of science, mathematics and technology; (ii) has deep conceptual understanding of scientific concepts and ideas and; (iii) appreciates that both the knowledge and practice of science are dynamic and constructed (Rutherford and Ahlgren, 1990).

OECD/PISA, for the purposes of its tests in 2000, defined scientific literacy as follows:

> *Scientific literacy is the capacity to use science knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.*

It assesses three dimensions of scientific literacy: (i) Firstly, *scientific concepts* which are needed to understand certain phenomena of the natural world and the changes made to it through human activity. In OECD/PISA, whilst the concepts are the familiar ones relating to physics, chemistry, biological sciences and earth and space sciences, they are to be applied to real-life scientific problems rather than just recalled. The main content of the assessment was selected from within three broad areas of application: science in life and health; science in earth and environment and science in technology. (ii) Secondly, *scientific processes* centered on the ability to acquire, interpret and act upon evidence. Five such processes present in OECD/PISA relate to the:

- recognition of scientific questions,
- identification of evidence,
- drawing of conclusions,
- communication of these conclusions and
- demonstration of the understanding of scientific concepts.

All but the last of these do not require a pre-set body of science knowledge. Yet since no scientific process can be "content-free", the PISA science questions inevitably required understanding of key scientific concepts. (iii) Thirdly, *scientific situations* selected mainly from people's everyday lives rather than from the practice of science in a school classroom or laboratory, or the work of professional scientists. As with mathematics, science figures in people's lives in contexts ranging from personal or private situations to wider public, sometimes global issues.

The conceptions of scientific literacy in PISA are of particular interest here as cross-curricular competencies and science processes are given particular emphases (Fensham & Harlen, 1999; Harlen, 2001). Scientific literacy is seen as the capacity to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity. The foci are the following science processes and cross-curricular competencies: Science processes: (i) recognizing scientifically investigable questions; (ii) identifying evidence needed in a scientific investigation; (iii) drawing or evaluating conclusions; (iv) communicating valid conclusions and; (v) demonstrating understanding of science concepts. Cross-curricular competencies: (i) self-regulated learning; (ii) ability to solve problems and; (iii) communication and co-operation.

The discussion contains three aspects of science, which are widely agreed on as necessary for a public understanding of science (Miller 1983, Driver et al. 1996, Sjøberg 1997):

- understanding some aspects of science content;
- understanding the scientific approach to inquiry;
- understanding of science as a social enterprise.

Finally, the recognition of the personal and social value of science provides the rationale and motivation to study the discipline. Individuals will display their scientific literacy in different ways, such as appropriately using technical terms, or applying scientific concepts and processes. And individuals often will have differences in literacy in different domains, such as more understanding of life-science concepts and words, and less understanding of physical-science concepts and words. Scientific literacy has different degrees and forms; it expands and deepens over a lifetime, not just during the years in school. But the attitudes and values established toward science in the early years will shape a person's development of scientific literacy as an adult.

This discussion on the definition of scientific literacy points to a fundamentally stark concern amongst educationists: the value of and motivations for a universalised definition of scientific literacy, and the politics of international tests, comparisons and textbooks. In what ways is a universalized concept of scientific literacy appropriate in a country such as South Africa? There are matters of poverty, language (English being spoken as a second language by the majority of South Africans), worldview (African/ Western, etc) and local needs (e.g., economic development means different things in different parts of South Africa). A homogenizing, hegemonic conception of scientific literacy has to be deeply questioned.

I draw from the discussion on the definition of scientific literacy, four dimensions of scientific literacy that will be used to locate ideological shifts: **science conceptual knowledge, science processes, science as a social enterprise, and communicating science.** Implicit in these dimensions are the goals, outcomes and nature of science. In drawing on these dimensions, my concern is not to reduce the concept of scientific literacy to knowledge, skills, values, context and language but to question: What knowledge, skills and values? And whose? Who decides on what conceptual knowledge to select? For what purposes is knowledge selected? On what scale is knowledge selected? And how is language used to frame the concept of scientific literacy? Is the goal of scientific literacy a shared rhetoric? How is this goal linked to politics of science and science education and the broad transformational politics of South Africa during these two reform periods? Questions such as these are central to the research method of 'policy archaeology': an intention to unearth ideological and political interests at work.

2.3 Ideology

2.3.1 Definition

A vast literature exists on the topic of ideology. The concept has its origin in the Greek *idea*, 'idea', and *logos*, e.g., 'the study of', 'the science of', and can in this way also be used in its literal meaning as the science of ideas. An ideology may be "any system of ideas regarding philosophic, economic, political, social belief and ideals" (Angeles, 1981:

126). 'Ideology' in the pejorative sense of false consciousness is perhaps most known within sociology of knowledge and the Marxist tradition. Suchting's (1983) stresses that ideologies are forms of consciousness; ways of seeing the world, world-outlooks, or as Marx expressed it, 'phantoms formed in the people's brain'. Ideologies as sets of ideas are independent of the material world but serve as creative forces and the aim of all social relations (Suchting, 1983: 136). The ideologist risks overlooking the ways in which social practices and institutions are carriers of ideologies, that ideology represents imaginary relationship of individuals to their real conditions of life, and so has a material existence (Althusser 1971:153).

Ideology draws from worldviews and philosophy, religion, politics, values, all of which might be expected to vary from one culture to another, one country to another. Cobern (2000) emphasizes worldviews and their roles in learning science:

> *Worldview is about metaphysical levels antecedent to specific views that a person holds about natural phenomena, whether one calls those views common-sense theories, alternative frameworks, misconceptions, or valid science. A worldview is the set of fundamental non-rational presuppositions on which these conceptions of reality are grounded (Cobern 1996: 585). . . . ...worldview is the sum of whatever number of cultural components (e.g., religion, aesthetics, ideology) a person embraces (Ibid., p. 587). . . . worldview is from cultural anthropology and is a comprehensive concept about the tacit dimension of cognition, subsuming both epistemology and metaphysics (Ibid., p. 593). A worldview is composed of those fundamental ideas that one simply takes for granted . . . because they are culturally learned and supported, and have been found through daily experience to be viable* (Cobern 2000 : 237).

The concept of worldview is especially valuable in its potential to "unpack or deconstruct the tacit metaphysical underpinnings of science curricula" (Cobern 1996:594). Worldviews are relevant not only to conceptions of science and explanation, but also to schooling more generally. For example Eisner (1992) in his 'curriculum ideologies' chapter in the *Handbook of research on curriculum* says that ideologies are about "beliefs about what schools should teach, for what ends, and for what reasons". Ideologies are "belief systems that provide the value premises from which decisions about practical educational matters are made" (p. 302). He underlines that ideologies are embedded in all cultures, languages and social practices, and can be "tacit rather than explicit" on a continuum from the most obvious, public and articulate statements of educational purposes, content, and rationale to the most subtle, private, and latent views (p. 305).

Unlike the Marxist view of ideology as 'false consciousness', Ernest's (1991) conception of ideology is closer to didactics. Ernest (1991), working in the context of mathematics education sees an ideology of mathematics as having three main parts:

(i) What people believe to be true of mathematics: The *absolutists* see mathematics as unquestionable, objective knowledge, while *fallibilists* view the subject as uncertain and unchangeable. Ernest relates the widespread negative public image of mathematics of being cold, abstract, difficult, ultra-rational and largely masculine, to absolutist philosophy of mathematics. In contrast an opposing humanized image of mathematics informed by constructivism and post-modernist thought is a basis for a reconceptualised view of the nature of mathematical knowledge as human, corrigible, historical and changing.

(ii) What people believe to be true about knowledge: A *dualist* sees knowledge as either right or wrong, but a *multiplistic* viewpoint is that knowledge may be sometimes wrong and sometimes right. This perspective provides no guidelines for choosing one perspective over another. The *relativist* position does provide guidelines. It argues that the truth of knowledge depends on its context.

(iii) Moral values, which can be dualistic, multiplistic, or relativist. Ernest (1991) separates moral values into two positions. The *separated* position holds that human issues should not affect judgment. The *connected* view argues that human relationships, empathy, and caring should influence decisions.

Using these analytic categories, Ernest (1991) identifies five ideologies of mathematics, each one associated with a particular subgroup of society, or social group.

__Summary of the Five Ideological Groupings (adapted from Ernest 1991)__

Interest group and Ideology	Industrial Trainer (dualist/absolutist ideology)	Technological Pragmatist (multiplistic/absolutist ideology)	Old Humanist (separated relativist/absolutist ideology)	Progressive Educator (connected relativist/absolutist ideology)	Public Educator (relativist/fallibilist ideology)
Politics	Radical 'New Right'	Meritocratic conservative	Conservative	Liberal	Democratic socialist
View of mathematics	Set of truths and rules	Unquestioned body of useful knowledge	Body of structured pure knowledge	Process view: personalised maths	Social constructivism
Set of values	Authoritarian values choice, effort, work	Utility, progress, expediency	Objectivity, rule-centered, hierarchy	Person-centered, 'Romantic' view	Social justice, critical citizenship
Theory of society	Rigid hierarchy, market-place	Meritocratic hierarchy	Elitist, class stratified	Soft hierarchy, welfare state	Reform inequitable hierarchy
Theory of ability	Fixed and inherited, realised by effort	Inherited ability	Inherited cast of mind	Varies, but needs cherishing	Cultural product: not fixed
Mathematical aims	'Back-to-basics': and social training in obedience	Useful mathematics and certification (industry-centered)	Transmit body of maths knowledge (maths-centred)	Self-realisation, creativity, via maths (child-centered)	Critical democratic citizenship via mathematics
Theory of learning	Hard work, effort, practice, rote	Skill acquisition, practical experience	Understanding and application	Activity, play, exploration	Active, questioning, empowerment
Theory of teaching mathematics	Authoritarian transmission, drill, no 'frills'	Skill instructor, motivate through work-relevance	Explain, motivate, communicate, pass on structure	Facilitate personal exploration and prevent failure	Discussion, conflict, questioning content and pedagogy.
Theory of resources	Chalk and talk only, anti-calculator	Hands-on and microcomputers	Visual aids to motivate	Rich environment to explore	Socially relevant, authentic data
Theory of assessment in mathematics	External testing of simple basics, avoid cheating	External tests and certification, skill profiling	External exams based on knowledge hierarchy	Teacher led internal assessment, avoid failure	Various modes. Use of social issues and content
Theory social diversity	Hierarchic by social class, Eurocentric	Vary curriculum by future occupations	Vary curriculum by ability only	Use local culture to humanise maths	Accommodate social / cultural diversity

The model makes no claims that individuals can be fitted into the five ideological positions, rather they define 'ideal types'. Notwithstanding this claim, the five discrete positions used here risk stereotyping patterns of belief – for example by suggesting that a particular political ideology with a particular teaching methodology or theory of resources. In this it closes off the possibility that ideological elements may be observed in complex combinations, overlapping several of the five positions.

There are instances in the science education literature where the concept of ideology is explicitly defined (e.g., Cross, 1997; Fourez, 1988; Knain, 1999, 2001; Turmo, 1999) and the concept itself is hardly discussed. However ethical or social ideas, values or impacts of these; philosophies of knowledge, science and instruction; the relations between science and society, religion and science etc. are common. Knain's (1999) definition of ideologies, inspired by the works of Aikenhead (1997), Cobern (1996) and Fourez (1998), focus on two ideological aspects: worldview and language. In his view:

- Ideologies are part of worldview. They have a cognitive element and influence the beliefs held by a person.
- Ideologies are, like worldviews, culturally influenced. People in a social group share them. At the same time they can influence people's world-view by social interaction. Ideologies can both be produced and reproduced. This way they can regulate a discourse.
- Ideologies are carried by language. Since ideologies are taken to be beliefs, values and expectation in a fundamental sense, they influence what is said and the manner in which it is said. At the same time they are present when the receiver interprets and makes meaning of an utterance (Knain, 1999: ixf).

2.3.2 Epistemological Dimension

a) Nature of Science Knowledge

Epistemology questions how learners come to know science, the nature of science and societies' purpose for science. Theories of learning express epistemologies not only through their status as theoretical knowledge, but in their concerns for how knowledge is acquired and judged as part of learning. Many authors such as Ohlsson, 1992; Kuhn, 1993; Solomon et al., 1994; Newton et al., 1999; Osborne, 1999, point to the epistemological bases of science, and commend scientific education that promotes particular ways of theoretical thinking and of reasoning. Scientific contents that are learnt at school, from the introductory levels onwards, should be *reasonable* and *reasoned*, and students should participate in a system of ideas and actions that is coherent, valid, and within their reach. A school science with these characteristics should allow students to adequately explain some of the relevant natural phenomena that they need to understand in order to live in today's society. Only with such epistemological foundations can science education be truly apt for a general *liberal* education, and this component – which gives value to school science – should be carefully investigated (Ohlsson, 1992; Bereiter, 1994; Cobb, 1994; Driver et al., 1994).

Turnbull (1997) distinguishes two major knowledge traditions that have differential power effects that do not in themselves arise from epistemology. The first is the **imperialist position**. In this position, scientific knowledge is uniquely distinguished by its rationality and methodology. It is universal, objective and true within the limits of its own fallibility. Its contemporary dominance is to be explained in terms of truth and rationality no matter what its socio-historical origins. Its methods are essentially experimental, reductionist and empirical. It is clear that what is at stake for proponents of this tradition is the superiority of Western civilization. Anything that feminists, sociologists or post-colonialists have to say that is critical of this view of science is deemed by these proponents, not just to be irrational and ideological, but an attack on democracy, truth and progress. From this perspective, there is no contradiction in science being both universal and Western: it is just that science emerged strongly from Western cultures. Non-Western knowledge can achieve full status as scientific knowledge if it meets the criteria of scientific practice; otherwise it must remain mere tradition or belief.

The second knowledge tradition is the **localist** position. Many have argued that all knowledge including scientific knowledge is value laden. Feminists, in particular, have argued that science is based in an essentially masculinist epistemology. They have argued convincingly that modern techno-science is exploitative, hierarchical and antithetical to women and many non-Western cultures. This critique has served as a corrective to the more apolitical sociological approaches of 'pure science' and has resulted in two basic positions. Either scientific knowledge should adopt a set of quasi-universal values, whether they be socialist, feminist, holistic, or whatever or it should be 'situated' within a particular set of values. This situated knowledge position has, in turn, leads to two subdivisions. One is to argue for the unique virtue of a particular value system such as

Islam or the wisdom of the elders. The other is to argue in support of pluralism of knowledge systems, and find ways in which they can coexist and/or learn from one another. This last position aligns itself closely with postmodern criticism of scientific claims: (i) it denies that there is just one valid way of knowing, one 'meta-narrative' to an over-arching search for truth; (ii) it insists that the context makes a substantial difference to any knowledge claim. In moral and ethical cases in particular the details of personal or cultural circumstances are important; (iii) the hegemony of scientific knowledge, the postmodernists claim, is no longer tenable. Not only is there public controversy among scientific experts (especially in finding solutions to complex environmental and ecological systems), there is also an underlying rage against reason. In anti-nuclear, environmental and other special-issue circles, adherents claim the right to decide for themselves on quite other grounds than expert logic and; (iv) there is a growing rejection of the notion of holding a uniform, and rather blinkered, world-view. In one sense this is just another aspect of the `meta-narrative' already rejected, but it applies also to the creation of our personal visions, selfhood and identity.

Guided by research findings that explore cross-cultural perspectives in teaching and learning science in both Western and non-Western countries (e.g., McKinley *et al,* 1992; Costa, 1995; Ogawa, 1995; Aikenhead, 1997, 2000; Cajete, 1999; Jegede and Aikenhead, 1999; Kawagley and Barnhardt,1999; Cobern and Loving, 2001; Snively and Corsiglia, 2001 and; Stanley & Brickhouse, 2001), Turnbull (1997) advocates the creation of a 'third space' in which Western and non-Western science traditions are viewed spatially. Knowledge is not only abstract and representational but also performative (Pickering, 1995); it is historical, contingent, and spatial in that it links people, skills, local knowledge and materials (Turnbull 1997). From this performative perspective, argues Turnbull (1997), objectivity and universality cease to be unique characteristics of Western science; rather these traits are effects of the collective work of knowledge producers in a given knowledge space. To move knowledge from the local to the global and vice versa, the key is to create assemblages, make linkages and negotiate equivalences between the components of various relevant knowledge traditions. By recognizing science as a set of local practices, continues Turnbull (1997), it becomes possible to de-center it and develop a space within which all knowledge systems can be performed together. Some traditions move and assemble knowledge through art, ceremony and ritual; science does it through mathematics and writing, disciplinary societies, instruments, and standardized techniques (Turnbull, 1997). In either case, knowledge assembly is achieved through making connections and negotiating equivalences while simultaneously establishing a social order of trust and authority resulting in a knowledge space. From this perspective, universality, objectivity, rationality, efficacy and accumulation cease to be unique and special characteristics of techno-scientific knowledge. An essential component is the social organisation of trust. As Shapin (1999) has argued, the basis of knowledge is not so much empirical verification (as the orthodox view would have it) but trust. Trust, he claims, is quite literally, the great civility. Participants in scientific communities, overall, trust researchers to report honestly, to give and take criticisms civilly, to give credit for ideas and discoveries, so that consensus and civil discensus can occur.

In *The Consequences of Modernity*, Giddens (1990) argued that the increasing sophistication and specialization of modern science has led to a situation where the 'weak inductive knowledge of lay people' means they cannot hope to follow science. Shamos (1995) made much the same point when pointing out that the boast of scientific literacy in its empowerment of the citizen to assess the validity of expert advice, is unattainable in practice. Threats and arguments lying on the frontiers of what is known, whether in particle physics, molecular biology or climate change, bewilder most scientists too. Because emerging science-based technologies, from war technologies to gene therapies, clearly present risks that may be personal and intimate, or large scale and catastrophic, this forced dependency on scientific experts is not trivial. The public is asked to trust not only the experts' understanding of what is incomprehensible to it, but also to trust that science in it-self is capable of 'correct' answers. There is considerable evidence that such trust in science and scientists can be misplaced.

b) *Theories of Learning*

Theories of learning express epistemologies not only through their own status as theoretical knowledge, but in their concerns for how knowledge is acquired and judged as part of learning. Recently, in parallel with arguments outlined for the nature of scientific knowledge, there have been powerful developments towards pluralistic epistemological frameworks (Greeno *et al*, 1997) in order to adequately address the many facets of learning emphasized by different theories. In science education Duit (1998) and Duit and Treagust (1998) are among those commending multi-perspectives theoretical approaches in order to allow researchers to model teaching and learning processes sufficiently and to address higher levels of scientific literacy. For science education as a discipline, there is at present considerable agreement about the most important theoretical concepts (see for example Gil-Pérez, 1996; Lijnse, 2000). Among these are: (i) *meta-cognitive processes*, related to the goal of helping students to think in an autonomous way; (ii) *students' conceptions*, related to the goal of teaching them how to think theoretically; and (iii) *didactical transposition*, that is, the idea that science is profoundly reconstructed in order to be taught (Ogborn et al., 1996). In addition, regarding the increasing importance that is given to *argumentation* and *explanation* in science education (Lemke, 1990; Newton et al., 1999; Osborne, 1999), the discursive and rhetorical aspects of scientific activity in the classroom have particular relevance. The so-called *cognitive model of science* from contemporary philosophy of science portrays science as a human enterprise whose aim is to interpret the world by using human capacities of thinking theoretically and progressing towards a goal (Newton-Smith, 1981; Giere, 1988, 1992). This model could explain both scientists' science and school science in spite of the big differences between them, because the *cognitive* goal is a central feature for both. At the same time, conceptions of knowledge as discourse – whether between people and people or people and nature – point to limitations of purely cognitive models of learning, and call for recognition of participative epistemologies (eg. Tarnas, 1996 and Moodie, 2003) and the non-cognitive aspects of experience and learning.

2.3.3 *Metaphysical-Ontological Dimension*

Ontology concerns the nature of reality. It is one thing to accept that scientific theories offer powerful ways of describing, explaining and predicting reality, but quite another to claim that they represent reality, or that they are reality. In traditional African thought, for example, science is seen as offering a useful but limited view, in that it ignores spiritual life and spirit forces, and too readily sets aside context, continuity and collectivity in favour of objectivication and reductionism (Malcolm & Alant, 2004). In South Africa Christian, Islamic and Hindu religious views are also important, as they are in many countries. In recent years the debate on the religion-science issue has been revitalized, usually in relation to Christian religions (e.g., Matthews 1996; Poole, 1995; Sewall 1999; Smith 2000). Research has included studies of students, teachers, scientists and science educators and their thinking on the religion-science issue and their views on learning, (e.g., Brickhouse *et al,* 2000; Downie and Barron 2000; Ebenezer, 1996; Egan and Francis, 1992; Evans, 2001; Francis & Greer, 1999; Jackson *et al,* 1995; Loving and Foster, 2000; Roth and Alexander, 1997). Implications for science education from non-Christian religions perspectives are also discussed (e.g., Hua et.ai. 1999; Nasseef 1994).

2.3.4 *Axiological Dimension*

Axiology deals with values, ethics and aesthetics. There is a close relation between *values* and *ideologies* (Johnson 1993). Ideologies are typically regarded as "value-laden commitments" (Eisner 1992: 303). The concept of value is a rather loosely defined term, and the literature on this topic is growing (e.g., Allchin, 1998; Matthews, 1999). For example Witz (1996) discusses values for science education from a deep-based relation to and respect for nature (a deep-ecological position). Teaching of ethics in science highlights values and questions about values: environmental issues, genetic engineering, animal suffering, health education; gender, poverty, ethnicity, home culture, and disability. Ethics, science and education are "inevitably and inexorably conflated" (Reiss, 1999:120). Hence, definitions of scientific literacy inevitably have axiological dimensions as well as epistemological and ontological ones. All three need to be excavated and discussed if we are to understand why the South African policy statements took the shape they took.

2.4 Curriculum Emphasis

Curriculum emphases are expressions of what the curriculum emphasizes about the subject matter. Roberts (1983) identified seven emphases, at the same time cautioning that any one curriculum emphasis is no more correct, true, or academically respectable than any other. Each represents an area of human endeavor that has its counterpart in human affairs. Although Roberts (1983) curriculum emphasis are in many ways about purposes, their inclusion is useful here to see what purposes have framed selections of scientific knowledge in the curriculum.

(i) *Everyday applications:* emphasizes science to understand and have some control over everyday, familiar objects and events, both natural and human made.

(ii) *Structure of Science:* emphasizes how scientific ideas develop and change. This emphasis stresses the significance of evidence, such features of 'scientific method', the roles of analogy, hypothesis, and experiment, the characteristics of scientific concepts and theories, and-to a certain extent-the historical evolution of scientific ideas. The academic discipline most closely associated with this emphasis is the philosophy of science.

(iii) *Science-technology-decisions:* emphasizes decisions about issues that have a recognizable scientific component. It brings out the point that scientific explanation is not the only consideration in such decisions. Values, ethics, economics, and politics are among the important perspectives on such issues as well. Recently, the emphasis is much more familiar as science-technology-society. Academic disciplines allied with this emphasis include ethics, political sciences, and economics.

(iv) *Scientific skill Development:* gives emphasis to conceptual and manipulative skills, collectively labeled as 'scientific processes'. These in turn are key at arriving at good, reliable 'products' (ideas as well as artifacts) in science. The emphasis concentrates on the *means* of scientific inquiry. The related academic disciplines are philosophies of science that selectively stress the formal, logical features of science.

(v) *A correct explanations* emphasis conveys to students that the purpose of learning science is to gain access to the best explanations available for natural events and objects. It concentrates on the ends or conclusions of scientific enquiry- especially on their 'correctness'. The academic counterpart is the canon of currently accepted explanations within the scientific disciplines themselves.

(vi) The *self as explainer* or *personal explanation* emphasis suggests to students that explanations in science, like their own, are influenced by the explainer's purpose and by the intellectual and cultural preoccupations that form their context. This emphasis is manifest in teaching and curriculum based heavily on constructivism-especially the attention to students' prior knowledge and learning purposes. Academic allies of this emphasis are found in disciplines concerned with intellectual and cultural perspectives on human institutions, as sometimes found in the history of science and the history of ideas.

(vii) *Solid foundation* is an emphasis on preparing students for further learning in science, especially next year's school programme, then the next year's, and so on through graduate school. A common assumption in this emphasis is that a central purpose of science education is to prepare and select students for tertiary science studies. The academic counterpart can be found in the curricula and organization of university science departments.

It is common in science curriculum discourses that individuals have strong positions about the importance of each of the curriculum emphasis. The different emphases express different value positions, so that deciding the relative emphases is a political struggle in a democratic society. Interestingly, in science education, the struggle about emphases is often greater than the struggle about science content: in spite of shifts in emphasis that occur from one curriculum reform to another, the 'basic content' or science knowledge and skills remain much the same (Roberts, 1983).

2.5 Conclusion

In this chapter I have explored different notions of scientific literacy and have delineated four aspects: **science conceptual knowledge, science processes, science as a social enterprise, and communicating science (i.e., the discourse of science).** Implicit in these dimensions are the goals, outcomes and nature of science. I then explored ideology, drawing attention to epistemology, ontological-metaphysical and axiological claims. I then recruited Roberts (1981) 'curriculum emphases', as a way of bringing together ideological concerns and conceptions of scientific literacy.

My goal here has been to provide an interpretive toolbox that I can use to interrogate data from interviews, questionnaires and policy documents. I want to interrogate two aspects of curriculum. The first concerns shift in the ideological orientation towards scientific literacy and the second the conceptual knowledge itself. What conceptual knowledge is in the policy documents; what is missing? How is the conceptual knowledge put together as a formal culture? What is expressed in the organization of knowledge itself?

In Chapter 3, I add to this toolbox, searching for a methodological approach to policy analysis.

Chapter 3

POLICY METHODOLOGY

The problem always remains that by focusing on the figures that move across the policy landscape, we may neglect the geomorphology of the landscape itself and changes in its terrain and substructure. On the other hand, a preoccupation with dominant modes of political rationality and global economic forces may lead to a misleading neglect of transformative activities and the possibility of surprise.
(Ball 1994a: 118)

3.1 Introducing the term 'policy analysis'

In presenting a theoretical framework on methodology I draw on the literature on policy and policy analysis. Policy analysis is a form of enquiry that provides either the informational base upon which policy is constructed, or the critical examination of existing policies. The former has been called analysis *for* policy, whereas the latter has been called analysis *of* policy (Gordon *et al,* 1977:27). Analysis of policy can take two different forms: (a) *analysis of policy determination and effects*, which examines 'the inputs and transformational processes operating upon the construction of public policy' (Gordon, *et al.* 1977:28) and also the effects of such policies on various groups; and (b) *analysis of policy content*, which examines the values, assumptions and ideologies underpinning the policy process. Lasswell (1970) speaks of 'knowledge in' policy making to refer to analysis of policy as compared to 'knowledge of' policy making referring to analysis for policy. Similarly, Hogwood and Gunn (1984) make the distinction between *description* (how policies *are* made) and *prescription* (how policies *should* be made). They show a distinct bias towards prescriptive analysis – towards an analysis of the policy process and policies themselves.

Hogwood and Gunn (1984: 27) neatly classify the kinds of studies comprising policy analysis in terms of: (i) studies of policy content: the origins, intentions and operation of policies. Such studies may help to inform policymakers but their aim is primarily descriptive, though the analysis may be at a highly abstracted level; (ii) studies of policy process: the concern here is how policies are actually made in terms of the actions taken by the various actors at each stage. This can consist of individual case studies or attempts to devise generalizable, but largely descriptive propositions about the nature of public policymaking; (iii) studies of policy output: these seek to establish the determinants of the pattern of distribution of expenditure or other indicators of policy outputs; (iv) evaluation studies: these seek to assess specific policies in terms of the extent to which their outcomes have achieved the outcomes of the policy; (v) information for policy making: this refers to the collection and analysis of data with the specific purpose of aiding a policy decision or advising on the implications of alternate policies. Such analysis differs from 'content' studies in that it is explicitly designed to contribute to policymaking; (vi) process advocacy: the analyst is here concerned not simply to understand the policy making process but to change it – usually with a view to making it more 'rational'. The emphasis is less upon what any particular policy should be than with *how* policies ought to be made; (vii) policy advocacy: this involves use of analysis in making an argument for a particular policy.

They also distinguish between (a) the analyst as a political actor and (b) the political actor as analyst. They see both roles as controversial. Political actors and their advisors may be viewed with suspicion in analytic findings that will tend to support positions they wish to adopt or to vindicate positions already adopted. My research study centers on the analysis *of* policy with emphasis on the policymaking process as well as the content of policy documents, i.e., a descriptive analysis attempting to unravel the policy process.

Theoretical arguments for the analysis *of* policy range from the rational model (Simon, 1957, 1960, 1983; March and Simon, 1958), to critical policy analysis. The policy process is messy. A rational approach to the process has value but is simplistic and limited. Hence critical approaches are more appropriate to my research question. Although some attention has been given to the development of 'policy oriented qualitative research' (Finch 1984), as Ball (1990:9) has noted, the field has been dominated by commentary and critique rather than empirical research. Much education policy research, as Maquire and Ball (1994b) note, has been methodologically unsophisticated, with issues of language and meaning taken for granted. In settling on a methodological framework to underpin this study, I offer an exposition on why traditional approaches are limited in attempting to explain and illuminate the policymaking process in the development of post-apartheid curriculum policy. I then evaluate the application of critical policy analysis drawing heavily from post-structural constructs of discourse analysis, power and knowledge. Ball (1990) argues that recent theoretical developments around post-structuralism offer 'a new set of tools to begin to explain things' (18). Post-structuralists suggest that there is a close nexus between power and knowledge, and that meaning is constructed historically in contested social domains (Foucault 1980).

I conclude this chapter by providing a discussion on the selection of constructs from the various frameworks to frame this study. Below I attempt to spell out the assumptions of the frameworks including the silences implicit in each.

3.2 Frameworks for policy-research

a) The Rational Model

Rational models begin from the question: How *would* policies be made if policy makers pursued and were capable of complete rationality? According to Hogwood and Gunn (1984) the two approaches to be adopted here are: (i) considering values simultaneously with considering options; (ii) setting out objectives at the beginning and then subsequently considering options designed to fulfill those objectives. A prominent writer concerning this model is Simon (1957). Rational policy making involves logical steps : (i) *intelligence gathering:* in a completely rational world any policy making agency would continually and systematically scan its horizon, seeking to identify all present and potential problems relevant to its mission or interests; (ii) *identifying all options;* (iii) *assessing consequences of options;* (iv) *relating consequences to values:* here the concern is with a the selection of preferred behavior alternatives in terms of some system of values whereby the consequences of behavior can be evaluated and; (v) *choosing a preferred option.*

An alternative type of rational decision-making stresses the importance of specifying objectives before looking for options that might achieve them. This approach is described by Lindblom (1959) where the policy maker: (i) defines and ranks governing values; (ii) specifies objectives compatible with these values; (iii) identifies relevant options for achieving these objectives; (iv) calculates the consequences of these actions and compares them and; (v) chooses the option or combination of options that maximizes the values earlier defined as being most important.

Rational models have been criticized as being unrealistic or impracticable. Supporters of this approach however contend that this is an ideal type approach, intended neither to represent reality nor present a blueprint for action. Another criticism of this model is that it is not sufficiently dynamic. The decision-maker might acquire perfect knowledge of the present (static) situation but cannot have similar knowledge of an essentially unknown future situation in which external and unpredictable factors may prevent the anticipated consequences. However, the main criticism with rational models is the part played by values. Rational models are about rational procedures for developing an argument or taking a decision and do nothing to guarantee the desirability of values fed into it or the validity of values that are assumed (Simon, 1983). Rational models deal with the structure of activities as part of policy making, but not the influences of events and interactions in the policy process. To understand the influences on the policy process it becomes necessary to turn to policy models that seek to explain the forces that shape public policy. Such forces are especially relevant in a state with an emerging democracy.

Hogwood and Gunn (1984: 50) identify five important categories of limitations to rationality in decision-making behaviour: *(i) psychological limitations*: limits to the individual policy-maker's powers of cognition and calculation; *(ii) limitations arising from multiple values*: the problem of values is further exacerbated when we move from individual to collective rationality. There is no rational way of resolving a conflict of interest; *(iii) organizational limitations*: even if individuals could overcome their personal limitations as policy-makers they would still find great obstacles as part of an organization. Organizations often fail to provide information needed for policymaking or perhaps the right information comes in an unusable form or too late to be useful; *(iv) cost limitations:* it costs to be rational, in terms of time, energy and money; *(v) situational limitations*: policy makers do not write on a clean slate, or decide in a vacuum. They are influenced by the past (e.g., by precedents), by powerful vested interests in the present, and by people's assumptions and expectations concerning the future.

Lindblom (1962) goes beyond identifying limits to rationality and demonstrates how real life policymaking has internal logic different from the assumptions of most rational models. For example, policymakers often avoid thinking through or spelling out their objectives. This may reflect a shrewd awareness that to do so would precipitate conflict rather than agreement. When it is clear that existing policies are failing to cope, the remedial action taken by legislators and administrators tends to be 'incremental': they make small adjustments to policies rather than sweeping changes. In doing so, they are moving cautiously and experimentally from a basis of what is known rather than taking a giant step into an unknown future. Policy makers accept that few, if any, problems are ever solved once and for all time. Instead policymaking is 'serial' (as mistakes are corrected and new lines of attack are developed). Few policies are made by individuals or even single agencies, but are instead made by the interaction of many actors operating in a power network ('poly-centricity'). While these actors are self-interested, they are not blindly partisan and are capable of adjusting to one another, through bargaining, negotiation, and compromise ('partisan mutual adjustment'). A value is placed on most pluralist liberal democracies on 'consensus seeking', so that what emerges is not necessarily the one best policy but rather the compromise policy upon which most groups can agree. My concern in this study is much more than consensus seeking but rather how did the consensus come to be? How were different voices mediated and negotiated? Whose voices were 'silenced/ unheard' in the process?

Dror (1964), whilst admitting the force of Lindblom's writings in the domain of description, viewed them as a dangerous over-reaction to the rational model as a prescription of what 'should be'. Dror focused his attack on incrementalism and consensus. He saw three circumstances in which incrementalism would be inadequate, namely: (i) present policies may be so manifestly unsatisfactory that merely to tinker with them is pointless; (ii) the problems requiring a governmental response may be changing so fast or so fundamentally that policies based on past experience are inadequate as a guide to future action; (iii) the means available for problem-solving may be expanding, so that major new opportunities exist but are likely to be neglected by incrementalists. The second criticism targeted consensus. Dror (1964) sees consensus as acceptable in terms of relative stability where there is informed agreement based on a relevant past. But in times of rapid change such lessons may not be relevant. 'Deceived consensus' may result.

b) The Process Framework approach

Hogwood and Gunn (1984) propose a process framework for analyzing public policy. The framework has the following stages, none of which need be entirely rational: (i) deciding to decide (issue search or agenda setting); (ii) deciding how to decide (or issue filtration); (iii) issue definition; (iv) forecasting; (v) setting objectives and priorities; (vi) options analysis; (vii) policy implementation, monitoring and control; (viii) evaluation and review and; (ix) policy maintenance, succession or termination. They see the dividing lines between the various activities as artificial and policymakers are unlikely to perform them consciously or in any particular order.

They claim the following advantages of this framework. Firstly, researchers can use a 'continuous film approach' rather than the 'moment of choice' variety adopted by case studies to show the dynamic nature of the process. Because movements through the stages need not be linear, as opportunities are created for feedback where the problem can be redefined, the process of analysis also will frequently be iterative. Secondly, process frameworks lend themselves to the identification and study of interactions amongst the various stages in the policy as well as various participating organizations and the larger social and economic environment. Thirdly, the process framework is flexible as it enables one to systemize existing knowledge without precluding the integration of future insights. The framework stresses the importance of analyzing the implications of each stage in advance of carrying it out.

The limitations to the process framework are that, firstly, the status of any model or framework needs to be made clear; secondly, the framework may degenerate into a straight-jacket, imposing upon future events an explanatory scheme that is inappropriate or misleading and, thirdly, the use of the model with its clearly defined sequence of stages may lead to rationalization, even when the acts in question do not lend themselves to such treatments. Hogwood and Gunn (1984) argue that, provided these possible dangers are kept in mind, the process framework is at least a 'way into' the analysis of policy.

The model is also incomplete in that it is silent about issues of participation, power, struggle for voice and exposition of ideological supremacy during the various stages of the process and the process overall. Hogwood and Gunn's (1984) were writing for British students of policy analysis, so many of their illustrations of the framework relate to the British context. The expectations of radical and rapid change in South Africa as the nation shifted to democratic government created a unique environment for policy development, one for which the process framework, by itself, is inadequate.

c) Carley's Framework

Carley (1987) breaks away from time-bound notions of process and depicts it as consisting of three elements: value-conflict and resolution, bureaucratic maintenance, and analytic rationality; and four activities: policy science, policy analysis, decision-making and implementation. I will focus on the three elements.

The *value-conflictive* element involves the promotion of values related to a multiplicity of goals and objectives. It involves processes such as negotiation, bargaining and mutual adjustment. The resolution may take the form of satisfactorily completed bargaining, or power wielding. Carley's model does not in itself address the dynamics of the power wielding that takes place in policymaking. Are issues resolved satisfactorily in a multi-vocal arena of policy making? Whose voice carries and what is the nature of the compromise? The *administrative or bureaucratic elements* includes routine activities employed for the purpose of simplifying the decision environment and avoiding conflict in the policy process, by means of standardized procedures and criteria for dealing with policy questions. However, the model gives no guidance on analysis of policymaking as a site of conflict and struggle. The third element is the application of *analytic rationality* to resource allocations. Most policy decisions are made up of some mix of these three elements of the policymaking process and the mix varies according to the nature and scope of the policy problem at hand.

d) Critical Policy Analysis

> *But, then, what is philosophy today- philosophical activity, I mean-if it is not the critical work that thought brings to bear on it-self? In what does it consist, if not in the endeavor to know how and to what extent it might be possible to think differently, instead of legitimating what is already known* (Foucault, 1985, p9).

Foucault (1985) in the last sentence of the above extract captures the essence of critical policy analysis: '*...to know how and to what extent it might be possible to think differently, instead of legitimating what is already known'*. Critical approaches to policy analysis question legitimacy and include neo-marxist approaches; conflictual rather than functionalist perspectives, post-structuralism and feminism. Troyna (1994:81-2) emphasizes the need for linkages between critical policy analysis and critical social research and approaches that are interested not only in what is going on and why, but also in doing something about it. Drawing on Harvey (1990), Troyna (1994) stresses that 'critical social research includes an overt political analysis against oppressive social structures' (1994:72) and practices (Taylor *et al*, 1997), concerning itself with how progressive change might occur and the desirability of alternative policy options. Ball (1994a) advocates an open and creative approach, choosing theories and concepts for the task at hand, rather than narrowly applying a particular model that might close off relevant theories and possibilities for interpretation. The framework for choice rests in principles of equity and social change. According to Ball (1994a) 'the task, then, is to examine the moral order of reform and the relationship of reform to existing patterns of social inequality, bringing to bear those concepts and interpretive devices which offer the best possibilities of insight and understanding' (p2).

In such an open framework, Kenway's (1990:24) 'what' 'how' and 'why' questions are useful ways to begin. More specifically, Kenway (1990) asks, 'what is the approach to education in terms of curriculum, assessment, and forms of pedagogy? 'How are such proposals organized?' in terms of funding and staffing arrangements, authority and administrative structures; and 'why have they been selected?' These questions relate to more general sociological questions such as: 'why was this policy adopted? On whose terms was the policy adopted? On what grounds have these selections been justified? Why and in whose interests? How have competing interests been negotiated' (Kenway, 1990: 24)?

Taylor *et al* (1997) add: Why now? Why is this particular policy on the agenda at this particular time? They move the focus to policy production and the broader policy context. Policy analysis is also concerned with exploring the impact of a particular policy when it is implemented, and they ask: 'what are the consequences?' In relation to this question, Ball (1994a: 26) distinguishes between first -order outcomes that relate to the goals of the policy, and second order outcomes relating to social justice. Analysis involves exploration of the nature, scope and distribution of first- and second-order issues, and of causal theories concerning underlying dynamics (Ball, 1989:69). However, given that policy is often as much about problem setting as problem solving, there are often difficulties in separating the policy and the issues, because policies frame issues in particular ways. Taylor *et al* (1997) see critical policy analysis as a focus on (i) understanding the context in which a policy arises; (ii) evaluating how the policy making process is arranged; (iii) assessing the content in terms of a particular set of educational values; (iv) assessing whose interest the policy serves; (v) exploring how it might contribute to policy advocacy; (vi) examining how policy has been implemented and its outcomes and effects. These are considered in some detail below, especially those dimensions that relate to my study.

(i) Understanding the context in which policy arises

Taylor *et al* (1997) posit that policy is more than text and to analyze only text is to overlook the nuances and subtleties of the context that gives the text meaning. Policies are dynamic and represent political compromises between conflicting images of how educational change should proceed. There is a prior history of significant events, a particular ideological and political climate, a social and economic context as well as individuals and groups that together influence the shape, timing and effects of policies (Taylor *et al*, 1997). My study will look at the text and context of policy formulation, focusing on 'knowledge of the policy process' (Lasswell, 1970) and the policy outputs.

(ii) Evaluating how the policy making process is arranged

In relation to the policymaking process, Taylor *et al* (1997) advise observing politics in action, tracing how economic and social forces, institutions, people, interests, events and chance interact. Issues of power, interest and management structures need to be investigated. Each policy player in some way contributes to how the policy develops and 'works', whether by speaking or not, by alliances or individually.

(iii) Assessing the content in terms of a particular set of educational values

Values permeate the policy process (Taylor *et al,* 1997), through the values expressed in the policy, and values underpinning the process itself. Consistent with this claim, Carley (1987) and Kingdom (1984) argue that politics also decides the **content of policy**. To add, Hogwood and Gunn (1984) state that one of the tasks of policy analysts is to tease out the theories and values underlying policies and to examine the internal consistency of the resulting model and the validity of its assumptions. Kingdom (1984) point to the intellectual dimensions of policy- making: to creating intellectual puzzles, getting into intellectual binds and extracting solutions from dilemmas. Schneider and Ingram (1989) contend that the instruments in policy and the ideas upon which they rest are as important as the exercise of power and influence that produces policy.

(iv) Assessing whose interests the policy serves

Taylor *et al* (1997) reject the positivist view of policy analysis as value neutral and grounded in facts provided by comprehensive and systemic observation. In their view observations are inevitably informed by the analyst's theories and values in ways which makes any absolute distinction between policy analysis and policy advocacy hard to sustain. If values cannot be avoided in policy analysis, then they believe they ought to be reflected on, declared and argued for up front. Clearly then, they see as a major task of critical policy analysis the investigation of how key terms are used, and the extent to which particular policies and practices are consistent with a moral vision for education. Critical policy analysis can expose the ways agendas are set and framed in favor of dominant interests and can identify and overcome obstacles to democratic planning. It can reveal ways in which information provided for consultation might be distorted/ false or misleading. Thus critical policy analysis is a synthesizing, interdisciplinary field of study (Taylor *et al*, 1997).

Henry (1993) argues that critical policy analysis is 'a value laden activity which explicitly or implicitly makes judgments as to whether and in what ways policies help to make things better' (Henry, 1993:104). This involves exploring the values and assumptions that underlie policies, conceptions of 'better' and the related issues of power. It leads to research questions such as, 'In whose interests?' and 'Who are the winners and losers?' in any particular policy initiative. It involves exploration of conditions preceding the policy initiative, to ways in which the policy problem and its context were identified and framed.

Policy analysis can be concerned with one or all of the stages of the policymaking process, but should not restrict itself to a policy document or text. The background and context of policies, including their historical antecedents and relations with other texts, and the likely short-and long- term impacts of policies are also important. This suggests a research framework that encompasses contexts, texts and consequences of policy.

Context

At its broadest, context refers to the antecedents and pressures leading to the gestation of a particular policy. These include economic, social and political factors that lead to an issue being placed upon the policy agenda, and the groups and social movements that pressed government to respond through the articulation of a policy statement (Rein, 1983). Thus the historical background of a policy, including previous developments and initiatives upon which policy is built, are important. It helps to illuminate the 'why' and 'why now' questions of critical policy analysis. Some of these issues are taken up later in the discussion on policy historiography (see section 3.3 (a)).

Analysis of Policy Text

The physical text is but one component in the policy process, with a history that led up to it and a future that will follow. It has an interpretational and representational significance, and will be read and applied in situations that all have histories. For example, policies enter existing patterns and structures of inequality. A policy is not exterior to inequalities, although it may change them; it is also affected, inflected and deflected by them. 'Policies are textual interventions into practice; and although many teachers are proactive, writerly readers of texts, their readings and reactions are not constructed in circumstances of their own making. Policies pose problems to their subjects, problems that must be solved in context' (Ball, 1994b:17). Textually, policy is surrounded by distinct discourses or frameworks, which are carried into implementation and analysis, which may lead to resistance and contestation.

Actors are making meaning, being influential, contesting, constructing responses, dealing with contradictions, attempting representations of policy. Policy ensembles, collections of related policies, exercise power through a production of 'truth' and 'knowledge' as discourses. Discourses are 'practices that systematically form the objects of which they speak. Discourses are not about objects; they do not identify objects, they constitute them and in the practice of doing so conceal their own invention' (Foucault 1977:49). Discourses are about what can be said, and thought, but also about who can speak, when, where and with what authority. Discourses embody the meaning and use of propositions and words. Thus certain possibilities for thought are constructed. Words are ordered and combined in particular ways and other combinations are displaced or excluded. Discourses get things done, accomplish real tasks, gather authority' (Said 1986:152). Policy as discourse may have the effect of re-distributing 'voice', so that it does not matter what people say or think, only certain voices can be heard as meaningful or authoritative (Ball, 1994:23). Policy's multivocal nature means that there is 'competition and cohabitation, convergence and divergence' (Kraak, 1999:38) among and between different policy discourses within single policy documents. These discourses can be apparently reconciled and seamlessly integrated through clever wording and the use of abstract and often ambiguous concepts. Policy documents are 'admirable in their sentiments and elegant in their formulation' (Christie, 1999:281).

Applications of discourse theory allow valuable fine-grained analyses of policy documents to be undertaken within a broader structural analysis. This approach is also useful in highlighting values and teasing out competing discourses, both in the development and implementation stages of the policy process. Discourse analysis can be used to help answer many of the major questions highlighting the subtleties of the ways language is used in policy making and illuminating how the policy process may work-particularly in relation to change (Taylor *et al*, 1997). However, it is important that such fine-grained textual analyses are placed in a broader context. Codd's (1988) formulation is useful here: 'Policy documents....are ideological texts which have been constructed in a particular context' (1988:243-4). Discourse theory can be helpful in relation to this task, for example in exploring the historical context of specific policies and how policy 'problems' are constructed. It is also useful in highlighting how policies come to be framed in certain ways, in other words in pointing to the ways in which economic, social, political and cultural contexts shape both the content and language of policy documents. For example, discourse theory can be used to analyse significant changes in the framing of approaches to educational inequality, and in key concepts that have been used in education policies (Rizvi & Kemmis, 1987; Connell & White, 1989).

As Apple puts it: 'Concepts do not remain still for long. They have wings, so to speak, and can be induced to fly from place to place. It is this context which defines their meaning' (1993:49). Words and concepts change their meaning and their effects as they are deployed within different discourses. Policies embody claims to speak with authority, they legitimate and initiate practices and they privilege certain visions and interests. The discursive process is also cumulative and ad hoc. It cannot simply be reduced to the intentions and ambitions of a few key actors. Each contribution, from whatever source, ramifies and re-articulates existing concerns and assumptions. In a sense, the discourse speaks for itself and policy makes itself. It is not a process of fine, strategic, political control. Policy as *settlement* is attempting to suture together and over matters of difference between the participating and competing interests in the processes of policy text production. Such texts contain divergent meanings, contradictions and structured omissions, so that different effects are produced on different readers. An important task of policy analysis is to examine those effects and expose the ideological processes that lie behind the production of the text. Thus it is suggested that the analysis of policy documents could be construed as a form of textual deconstruction (Codd, 1988).

At another level, drawing more on discourse theory, we can move to the area of language and explore further the way equity issues are framed within the document. At yet another level one could focus on linguistic strategies used by the text, for example the devices used to address the reader (Luke *et al.* 1993). In the one-page policy framework, and particularly in the statement of educational values and principles, the language is clear and directive with frequent use of the verb 'should' to indicate that action is imperative.

In a linguistic sense what is not said is often as important as what is said. Thus an analysis of *silences* of the policy may be telling.

Consequences

Some of the contextual complexities and competing interests involved in policymaking could actually be manifested as ambiguities in the policy document itself, with implications for how policy is read and implemented. Sometimes the suturing of difference within the policy settlement means that very different things can be done legitimately in the processes of policy implementation. Different interests can give very different emphases to various aspects of policy (Taylor *et al*, 1997), in what is sometimes referred to as policy refraction (Freeland 1981). Even without any obvious ambiguities in a policy text resulting from competing interests, there will be no single interpretation of a policy document. This means that predicting the effects of policy is never easy.

3.3 The Framework that underpins the methodology of this study

The complexity and scope of policy analysis – from the workings of the state to contexts of practice and the distributional outcomes of policy - preclude the possibility of single-theory explanations (Ball, 1994b). A toolbox of concepts and theories is required – an applied sociology rather than a pure one.

That toolbox must provide ways of operationalising critical policy analysis as a research methodology. As mentioned earlier, the rational approach has value but is limited if one wants to 'think differently instead of legitimizing what is already known' (Foucault, 1985: 9). Policy documents are also ideological texts, constructed in a particular context. My concern in this study is how the policymaking process was structured and what constructs/ ideologies and politics framed the selection of conceptual knowledge and the conception of scientific literacy. My own framework of concern is for inclusivity and social justice. Thus a critical part of this study is the relationship between power and knowledge - at the level of the policy writing process (the power of the pen) and at the level of schooling, where more powerful people decide the knowledge to which pupils have access.

I draw on the work of Gale (2001) in operationalising critical policy analysis as a research method, through the techniques of policy historiography, policy archaeology and policy genealogy. These techniques flow from the framework of critical policy analysis described above.

(a) Policy Historiography

Historical accounts of education trace the process of educational change and expose the possible relationship between the socio-educational present and the socio-educational past (Kincheloe, 1991). Policy historiography asks three broad questions:

(i) What were the 'public issues' and 'private troubles' within a particular policy domain during some previous period and how were they addressed?

(ii) What are they now, and

(iii) What is the nature of change from the first to the second?

Critical policy historiography adds a further two:

(iv) What are the complexities in the coherent accounts of policy?

(v) What do these reveal about who is advantaged and who is disadvantaged by these arrangements?

Theorising policy in this way, I present in Chapter 5 a historical account of the development of the Natural Science curriculum policy through unmasking ideologies in the conception of scientific literacy, i.e., the chapter is not only framed by policy historiography as research methodology but the account is presented through a story-line of ideologies that framed and informed the conception of scientific literacy and the selection of science concept knowledge.

(b) **Policy Archaeology**

Scheurich (1997) has written an instructive account on this method and its relevance to policy analysis. Taking archaeology as its metaphor, it excavates the policy process, looking for structures, conditions and cultures that gave rise to the policy. Policy archaeology is not a study of the history of the emergence of a social problem, but what Mahon (1992) called investigation of the historical *apriori*. Policy archaeology investigates the constitutive grid of conditions, assumptions, and forces that makes possible the emergence of a social problem, its strands and traces, and possible solutions. Scheurich (1997) defines four arenas of study or focus:

> Arena I: The education/social problem arena: the study of the social construction of specific education and social problems.
>
> Arena II: The social regularities arena: the identification of the network of social regularities across education and social problems.
>
> Arena III: The policy solution arena: the study of the social construction of the range of acceptable policy solutions.
>
> Arena IV: The policy studies arena: the study of the social functions of policy studies itself.

Scheurich(1997) cautions that even though policy archaeology is divided into four arenas, all of which have permeable boundaries, that the policy archaeology process is recursive or iterative; work on any particular problem-policy axis passes through all four arenas, and, thus, work in one arena may refashion or alter what has already be done in another arena. The construct of archaeology permeates all chapters of this thesis but is fully elaborated in Chapter 6. As policy studies falls out of the scope of the study I will not make use of Arena IV. I will also not treat the first three arenas as separate entities but allow the story to flow from the archaeological accounts of the process. My intention in this chapter is not to present the policy process as the 'truth' but to dig deeper and understand the rules of the game of how the truth came to be. The intention here is to unearth how the details of the structure been resolved. I will explore three broad frames of reference to excavate the policy process: the people involved in the policy process, the structures that constrained or facilitated the process and the form of policy documents.

I will draw on the relevant concepts in each of the first three arenas to inform the analysis.

Arena I: The education/social problem arena: the study of the social construction of specific education and social problems.

Instead of accepting a social problem as an empirical given, this arena questions this given-ness. Policy archaeology, refusing the acceptance of social problems as natural occurrences, examines closely and skeptically the emergence of a particular problem. It asks specifically:

(i) By what process did a particular problem emerge (i.e., how did a particular problem come to be seen as a problem)?

(ii) What makes the emergence of a particular problem possible?

(iii) Why do some problems become identified as a social problem and other problems do not reach that level of identification?

(iv) By what process does a social problem gain the gaze of the state, of society and thus, emerge from a kind of social invisibility into visibility?

Arena II: The social regularities arena: the identification of the network of social regularities across education and social problems.

"Social regularities" consist of patterns of thought and ways of thinking that permeate the policy process. Scheurich (1997) makes four points about them. Firstly, the regularities are not intentional, in that no particular individual or group consciously created them (though some individuals and groups benefit from them). Social orders are continuously re-established by networks of social regularities without the need for controlling agencies. Secondly, while social regularities determine social problems and policy solutions, they operate neither as outside nor inside forces; they constitute rather than set the conditions in which action is taken. Thirdly, regularities change, perhaps even disappearing or being created. Policy archaeology posits that it can not only identify the regularities but also delineate shifts in regularities. In addition, policy archaeology is itself emergent within a particular historical period; consequently historical changes may lead to the decline and disappearance of policy archaeology as a relevant methodology. Fourthly, regularities operate largely below the surface; social agents may or may not be self-consciously aware of the social regularities shaping their subjectivities and practices.

Policy archaeology is premised on the idea that there are powerful grids or networks of regularities that are constitutive of the emergence or social construction of a particular problem as a social problem, regularities that constitute what is labeled as a problem and what is not labeled as a problem. This arena seeks to identify such regularities. In Chapters 5 and 6, I identify two regularities that are constituted by the policy problem and arise from the data. They are governmentality and professionalization.

Arena III: The policy solution arena: the study of the social construction of the range of acceptable policy solutions.

Just as social problems are constituted by the grid of social regularities so is the range of acceptable solutions. The grid of regularities constitutes some policy choices as relevant and others as virtually invisible; it privileges some choices over others. This arena, then, is the study of how the grid of social regularities generates the range of possible and unacceptable policy solutions.

(c) Policy Genealogy

Genealogy is a "history of the present" (Foucault in Dreyfus & Rabinow, 1982:118). Taking genealogy as a metaphor, it looks at a policy's development from earlier forms. Through genealogical investigation, present problems can be examined through a new lens, outside traditional modes of inquiry in the social sciences. The present rather than the past thus becomes the object of inquiry. By asking specific and definite questions in the present tense, it is possible to investigate past practices. In this way the legitimacy of the present can be undercut by the foreignness of the past, offering the present up for re-examination and further enquiry. This should not be taken to mean the discovery of simple continuities between past and present, and parameters and particulars, for 'genealogy seeks out discontinuities where others found continuous development' (Dreyfus & Rabinow, 1986). Policy genealogy is not convinced by the analyses of policy production explained by 'bounded rationality' (Simon, 1960) or 'incrementalism' achieved through 'partisan mutual adjustment' (Lindblom, 1959). As such policy genealogy seeks to ask:

(i) how policies change over time

(ii) determines how the rationality of the policy production might be problematised, and

(iii) how temporary alliances are formed and reformed around conflicting interests in the policy production process?

3.4 Summary

I have attempted to infuse these constructs of policy genealogy with policy historiography and policy archaeology as these are artificial boundaries that gives insight to the policy process. That is for organizational reasons only. I devote Chapter 5 to predominantly a discussion and examination along the lines of policy historiography and ideology, and Chapter 6 to policy archaeology. In the next chapter, I present the research methodology that underpins this study.

Chapter Four

Though there be madness, yet there is method[1]!

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.
T.S. Elliot

4.1. Introduction

This study set out to answer one main research question: *What are the theoretical, methodological and contextual constructs that frame the conception of scientific literacy in the Natural Science Curriculum?* This chapter serves to illustrate my role as researcher as well as outlines the detailed research methodology that was used to answer the critical research question of this study. This study entailed probing who has been involved in the policy writing process and which organizations they represent; policy writers' perceptions of the policy making and policy writing processes; and the science conceptual knowledge that policy writers deem valuable to be included in the curriculum policy documents. I also conducted an in-depth analysis of key policy documents to trace the ideological shifts in the conception of scientific literacy. The two key sources of data were policy writers and policy documents.

This chapter consists of three sections. In Section One of this chapter: *Setting up the research design,* I provide a narrative account of how the research design of this study unfolded.

[1] Inspiration for title from published PhD dissertation of S. Singh (2000): "Intruders in the Sacred Grove of Science"? A Critical Analysis of Women Academics Participation in Research in the Humanities and Social Sciences.

In Section Two, *Data collection plan:* I focus on how the research choices I made attempted to answer the critical research question of the study. I present a description of the sources of data, the sample, the design and kinds of instruments that were used to access the data. In this section I also attempt to record the nature of doing research in a complex, unstable and rapidly changing context such as that in the post-apartheid educational terrain in South Africa. I provide details of the strategy employed to answer the critical question as well as the methods employed to enhance the validity of my data.

In Section Three, *Analysing the data,* I present decisions made about how the textual as well as statistical data was analysed and presented.

4.2 Section One: Setting up the research design

The changes and adaptations in the research process were due mainly to various contextual factors, which emerged during the setting up of the research process and specifically the execution of the data collection and analysis. This is different from an "emergent design" methodology of research where there is a deliberate decision to allow the process of the research methodology to unfold in the course of doing the research (Vithal, 1998). I entered the research field with pre-formulated key questions and research strategies that I intended using in my study. I had also commenced with an already clearly formulated plan for data collection. Nevertheless, I was open to the possibility of being influenced by the specifics of enacting the research design and modifying and re-modifying my research plan along the way.

Initially I intended focusing on four periods under review in the development of the Natural Science Curriculum (GET phase) as they presented uniquely different influences of reform and have impacted on the conception of scientific literacy and the conceptual knowledge of science in different ways. These phases are pre-1994 (before South Africa's first democratic elections where the control of education was under nineteen different departments of education each with its own syllabus for Natural Science –then called General Science); 1994 (development of the interim core syllabus – a common syllabus to be used by all the different ex-departments of education); 1997 (the release of the common C2005 based on the philosophy of outcomes based education) and its review in 2000; and the development of the NCS (published in draft in 2001, and significantly revised for final release in 2002). However policy writers for the first two periods had long left the system and no proper records were kept of their contact details. Policy documents during these two periods reflected an insignificant ideological shift in the selection of conceptual knowledge and the conception of scientific literacy- except to say that in the pre-1994 period the curriculum strongly reflected the apartheid agenda of the state. A major source of literature (see Chapter 1) during the second period (1994-development of the interim core syllabus) was a major study conducted at Centre for Research in Educational Policy (CEREP), then under the directorship of Professor Jonathan Jansen. The study was a three-country research project in which the politics of transition as witnessed through the lens of the school curriculum was explored (Jansen 1993, 1995). The study assesses the political processes that initiated, governed and constrained the syllabus revision project. The analysis was constructed on the basis of extensive interviews with national co-ordinators of the process, some of the participants in the different field and phase committees, and officials in education departments; and a careful review of key documents, including the series of materials produced by the NETF (minutes of meetings; progress reports; internal interviews; founding documents; stakeholder circulars; submissions to the Minister); the school syllabuses themselves; assessments by different stakeholders (e.g. branch reports by the South African Democratic Teachers Union); newspaper reports; and selections from the more than 800 public submissions (Jansen 1999a). Consequently empirical data for my study was obtained for the latter two periods i.e., 1997 (the release of the common C2005 policy documents based on the philosophy of outcomes based education) as well as the review of C2005 and; the development of the NCS.

4.3 Section Two: Data Collection Plan

4.3.1 Gaining Access to key Policymakers/writers and documents

I proceeded with great difficulty and immense frustration of firstly determining who were the policy writers for the two periods (C2005 and RNCS) that I have chosen, and secondly, gaining access to these policy writers who were extremely busy people. They keep odd hours and are never at one particular place at any particular time. It leaves the researcher to draw a balance between 'hounding' the individual and being able to sense a polite refusal. I do want to however, thank those policy writers who saved time for me over a morning cup of coffee, or in between a Sunday shopping trip and Sunday brunch or a glass of wine before bedtime.

For the C2005 process, no formal records were kept of participants who attended the workshops for the broad learning area committees. I had to rely on the memories (sometimes failing but understandable due to the time period that has elapsed) of those policy writers I could track. Using the snowballing technique, I was able to locate key policy writers for the C2005 process. Fortunately, proper official records were kept in the RNCS process (as formal appointments of policy makers and policy writers were made), and that process of identifying policy writers could easily be obtained from the Department of Education's web site. I soon came to realise that my conversational mention of certain individuals in the scientific circle (e.g., my supervisor) had distinct advantages when it came to arranging interviews with policy writers and policy makers. However, due to the legality of policy makers/writers, appointments access to some policy makers did not proceed smoothly. Some policy makers despite anonymity refused to participate in the study. Reasons were offered which I could not include but I have been given permission to include the following:

> *you could say that I was not prepared to comment on the process, due to the fact that I have resigned voluntarily.*

I was not able to gain access to key documents (e.g., inputs from the public) as the Archival Act protects them. These documents are key to exploring influences behind the policy documents and once again I had to rely on the perceptions of policy writers of the process (the extent to which these perceptions were 'true' is questionable as they played both the 'referee and the player' of that information). Policy documents, however, were easy to obtain both at schools and at tertiary institutions. I also had at my disposal personal e-mail data that I had to use with sensitivity both to the sender and the receiver.

4.3.2. *Collecting data in disruptive contexts*

One of the characteristics of doing research is that the researcher is often expected to fulfill several roles simultaneously. On certain days I found it impossible to get away from my obligations at work and at other times found that I had to set up an appointment some distance away from home only to realize that when I get to my destination my appointment has been cancelled due to an unexpected meeting that has arisen. My data collection plans were disrupted and had to be rescheduled, sometimes re-strategising due to occurrences like the one above. Valero and Vithal (1998) suggest that "disruptions to carefully conceived plans" may take on more dramatic alterations within a rapidly changing context. They suggest that "disruptions to carefully conceived plans are the norm rather than exception" in research contexts that are undergoing fundamental transformations in their educational, social and economic order. For example: (i) Researchers may be simply unable to gain access to schools within which research was intended to be conducted. This may be due to class boycotts, student or teacher strikes, unscheduled closing of schools due to political or social problems. The school context is merely a microcosm of wider social changes, and therefore, a variety of macro- and micro- level factors come to be played out within the school context. As educational researchers, the clearly laid plans of data collection are often unable to be carried out; (ii) The research subjects within the context of a rapidly changing society are also characterized by a kind of evolutionary (if not radical) transformation of their own personalities, ideologies and beliefs. The evolutionary status of such change entails that data collected from subjects about their beliefs, ideologies, attitudes, etc, are potentially subject to a range of fluctuations. These fluctuations do not (as to be expected) progress in neat trajectories; (iii) Researching the subjective interpretations of research subjects may alter significantly in relation to time, place and context during the data collection process; (iv) The researcher is likely to find that research subjects often offer contradictory subjective interpretations about the same events. Research subjects may profess one set of claims on "Day One" and a completely different set of claims about the same issue a few days or weeks later; (v) As a researcher one may also find wide gaps between what the research subjects say (for example, about their classroom practice) and what they actually do (in their classroom actions).

More specifically, pertaining to access to policy makers disruptions occur to cancelled appointments, interruptions of the telephone, contradictions in accounts of a process asked over two occasions etc.

4.3.3 The Policy Analysis Approach

Policy analysis is a form of enquiry that provides either the informational base upon which policy is constructed, or the critical examination of existing policies. The former has been called analysis *for* policy, whereas the latter has been called analysis *of* policy (Gordon *et al,* 1977:27). Analysis of policy can take two different forms: (a) *analysis of policy determination and effects*, which examines 'the inputs and transformational processes operating upon the construction of public policy' (Gordon, *et al.* 1977:28) and also the effects of such policies on various groups; and (b) *analysis of policy content*, which examines the values, assumptions and ideologies underpinning the policy process. For further reading into the policy analysis approach see Chapter 3. In Chapter 3, I also present the methodological framework that underpins this study.

4.3.4 Research Strategy

I conducted a pilot interview and sent questionnaires to two policy makers of the C2005 process. The pilot study served to identify the policy writers/makers perceptions of the policy process and their choices of science conceptual knowledge, validated the research instruments to be used, and informed the overall research design strategy. A full-scale study was conducted with all policy writers that I could locate and interview for the C2005 and the RNCS processes for the Natural Science Learning Area as well as policy makers in management that had some influence over the science policy writing process.

Data was collected over a period of one-year using a multi-method approach to data collection so as to overcome the limitations of any particular instrument as well as to crystallize evidence (see crystallization as an analytical tool in part 4.4.1 of this chapter). Multiple methods of data collection included using in-depth, semi-structured *interviews* (see appendix F for the interview schedule), identification of *critical incidents* in the policy process, *questionnaires (*see appendix G for a sample questionnaire) and the analysis of curriculum policy *documents* in the Natural Science Learning Area for the C2005 and the RNCS processes. There is a possibility that information gathered during the interview could be distorted. The major way to detect and correct distortion "is by comparing an informant's account with accounts given by other informants" (Merriam, 1988). The informants' accounts will also be cross-checked with documentary material.

The research methodology of this study can be described as the "Mixed Methodology Design Model" of combining qualitative and quantitative research methods. The mixed methodology design entails mixing aspects of the quantitative and qualitative paradigm at all or many methodological steps in the design. This approach to research requires a superior knowledge of both the quantitative and qualitative paradigms, links paradigms that may be unacceptable to some authors, and requires that the writer convey a combination of paradigms unfamiliar to many researchers. In my study the quantitative focus of the research manifested itself by the codification of policy writers' responses and the subsequent generation of frequency tables from the data in the questionnaire. The qualitative focus of the research was evident in the use of open-ended questions in parts of the questionnaire, the use of semi-structured interviews and data from the analysis of curriculum policy documents. In this study the two paradigms were inextricably linked but more focus is given to the qualitative paradigm as my population was extremely small.

The development of the instrumentation (questionnaire, interview and document analysis schedules) was an extremely iterative process. My supervisor, related literature as well as the curriculum policy documents inspired some questions in the instruments used. There were several versions of the instruments, which were reviewed jointly by my supervisor and my fellow doctoral students. The reviews ensured that the instruments were clearly focused to collect only data that was necessary to answer the critical question. All the instruments were piloted prior to use and responses were used to refine the instruments.

The following questions informed the design of the questionnaire and the structure of the interviews:

Theoretical Constructs

(1) Struggle for voice: Whose voice is represented and whose meaning is to be carried forward for inclusion in the curriculum? On what basis are decisions made? How is curriculum development related to dominant shifts in education reform (OBE, globalization, politics of transition)? What are the forces (political, economic, ideological) that are driving curriculum reform and what is the relationship between policy making at the national and the international level? What are the purposes of the science curriculum? Who is the curriculum meant to serve? What kinds of conceptual knowledge dominate/ are excluded? What is the notion of scientific literacy in the documents? What dominant ideological position can be inferred from the documents? What are the prevailing ideological, economic and political conditions?

2) Learning Theories: Which learning theories on effective science teaching shapes the policy choices made? What discourses influence the foregrounding of certain forms of knowledge? What is the knowledge base of policy makers that are used to construct the science curriculum?

(3) Assumptions: What assumptions do policy makers have of what is science, what constitutes the knowledge of science, science teaching and science learning and kinds of scientific classroom activities that result in positive pupil achievement?

Contextual Construct

To what extent has the contexts of schools been considered? What assumptions do policy makers have of the functionality of schools, kinds of learners and teachers? In what context has the policy emerged/exists? Without an understanding of the context in which policy emerges, it is neither possible to adequately understand the policy nor to strategize a response to it (Taylor et al, 1997).

Methodological Construct

Who is involved in policy making? How are processes of consultation arranged? Whose interest do they serve? Has the policy generated support for and understanding of the proposed curriculum change amongst teachers, parents, and the community at large?
To what extent has participation by the different interest groups influenced the final policy documents given other bureaucratic agendas and associated internal politics? What assumptions do policy makers have of the implementation process, curriculum development? Which interest (stakeholder) groups are represented in the production of the policy text and which are excluded? What processes are used to construct the policy text and why? What compromises are made between the different interest (stakeholder) groups and how were they achieved? Whose interests are the policies intended to serve? What are the dominant discourses of the policy text and which discourses are excluded? What is the stated intention or purpose of the policy? Are there any 'hidden' agendas? Which values are reflected in the policy? What are the issues that constitute the focus of the policy, and do they relate to global/international policy agendas? What are the key concepts of the policy?

4.3.5 The Sample: Who were the policy writers and policy makers?

The C2005 Process

The C2005 policy-making process for the Natural Science consisted of the National Learning Area Committee (LAC), a large group of about 50 individuals who were invited to two or three National workshops. This broad National LAC appeared to be a fluid committee, i.e., although registers were kept during these workshops, individuals were difficult to locate and different individuals were in attendance at different workshops. I was able to locate some of the individuals and below, in Table 1, is a profile of six of these individuals who were willing to be interviewed. The names of the policy makers are not indicated so as to protect anonymity. As a small number of individuals participated in the writing process and these individuals could be well identified by their profiles, I masked their inputs by referring to them in pseudonyms so that consistency in their responses could be traced but not at the expense of anonymity. The seventh policy maker was interviewed but was not willing to be profiled. Some members were nominated by various stakeholders to serve on the LAC, some members attended on their own accord. The brief of these eight National LACs (one for each learning area) was firstly, to write a rationale, and secondly, to identify learning area outcomes that reflect the critical crossfield outcomes as formulated by SAQA. To adhere to the principle of an integrated approach, five co-ordinating committees were established, one each for the Foundation Phase, the Intermediate Phase, the Senior Phase, Further Education and Training and ABET. The task of the Co-ordinating Committees was to identify cross-curricular issues in the eight areas of learning and to do the clustering of outcomes supplied by the National LACs into focuses for the eventual development of learning programmes. The Co-ordinating Committees each comprised more or less 26 members representing the various stakeholders. To take the work of the five co-ordinating committees further towards one broad curriculum, a Technical Committee was established. Nominations for appointment to the Technical Committee were invited through the Government Gazette. The Technical Committee was assisted by a Reference Group and comprised three members from each LAC, as well as two practicing teachers nominated by each of the eight LACs, and one ELSEN representative. Together with the co-ordinating committees, these three structures eventually developed all the inputs referred to above, into the curriculum for General and Further Education and Training that was announced on 24 March 1997 (DOE, 1997). The technical team for the Natural Science learning area consisted of three members, two of which have been profiled in the table[2] below. The

[2] Profiling the policing writers and policy makers is an attempt to show their affiliations which is key to the

third member, a female department official declined the invitation to be part of this research project. Profiling the policy writers in this way, displays who these individuals were and which voices they *may* represent. These aspects are fully explored in Chapters 5 and 6 where strong voices on particular positions emerged.

Table 4.1: *Profiling the policy makers of the C2005 process by profession, teaching subject area, level of schooling of interest, and experience of curriculum development in years.*

Policy Maker/ Writer	**Profession then**	**Teaching Subject Area**	**Level of Schooling of interest**	**Experience of Curriculum development at policy level in years**
1[3]	National director of an NGO	Natural science	Grade 4-12	0-5
2	University Lecturer	Natural Science	Grades 1-12	6-10
3	University lecturer	Biology	Grades 7 to tertiary	0-5
4	Director of an NGO	Physic/Chemisty	Intermediate to senior	16-20
5	Service provider/MPC/ Review Committee LAC	Natural science Botany Zoology Physic/Chemistry Biology	All	6-10
6	Co-ordinated union representative	Physics Chemistry Biology	11-15	11-15

construct of professionalisation.

[3] Policy writers/ makers will be referred to by numbers here and letters in the future chapters so as to protect anonymity. Policy writer 1 in the table above does not represent Policy writer A in later chapters of this thesis. This fulfills one of the criteria for authenticity, i.e., tacit authenticity.

Table 4.2: Profiling Policy Actors for the C2005 process by gender, experience of teaching science at school, qualifications and the institute/organization they represented.

Policy Writer/ Maker	**Gender**	**Experience of teaching science in years**	**Representation**	**Qualifications with specialisations**	**Role in the Process**
1	Male	16-20	NGO coalition	PhD M.Litt (curriculum development) NHED	Chair of LAC
2	Male		SAARMSTE	B.Sc (Maths, Biol) M.Sc (Maths, Biology) PGCE (Maths.Ed) PhD (Science Ed)	Chair of Technical Committee for Natural Science
3	Female	Under 10	LAC Gauteng	B.Sc (Hons) M.Ed	Member of LAC
4	Male	11-15	NGO	B.Sc (Maths and Physics Med	Member of LAC
5	Male	Under 10	Steering Committee for Association of science and technology educators SYSTEM (Students and Youth into Science, Technology, Engineering and Maths); National Centre for curriculum research and development (DOE); Further Education and Training Directorate	M.Ed (Sociology of education) B.Ed B.Sc U.E.D Maths and Physical Science B.Sc (Chemistry & Biochemistry)	Department Official
6	Female	11-15	Co-ordinated rep of unions	B.Sc (zoology) HDE (biology, geography) BED	Member of Technical Committee for Natural Science/ Represented co-ordinated unions

The RNCS Process

The NCS process consisted of the Ministerial Project Committee (MPC); Task Team (made up of coordinators for each working group); working groups for each of the eight learning areas; groups to address particular issues i.e., for the foundation phase, human rights and inclusivity, qualifications and implementation; a support group and a large reference group. The eight Learning Area Statements were developed by specific Working Groups assigned to each Learning Area. The Foundation Phase Working Group developed three learning programmes and interacted with the eight learning area Working Groups and the three transversal Working Groups outlined below.

The three special transversal groups were:

1. The human rights, civic responsibility and inclusivity working group, which considered the issues in relation to ELSEN, primary and secondary language, racism, sexism, poorly resourced schools, environment and so on. This Working Group had to:
   - clarify human rights concepts and values in the various learning areas and programmes
   - propose how to infuse these concepts and values into the learning area statements and programmes
   - suggest approaches and methods to assess these concepts and values in the learning programmes and how these contribute towards GETC
   - propose strategies to promote multi-lingualism in the learning area statements and programmes
   - suggest ways and means of ensuring that human rights education is a cross-curricular issue

2. The Qualifications Group had to
   - propose strategies to promote and accredit multi-lingualism in the GETC
   - suggest ways and means of designing down knowledge, skills and values per grade from the GET

- propose weightings of knowledge, skills and values in each learning area/programme per grade in the Senior Phase and how these make up the total number of credits in the GETC
- design rules of combination for different learning programmes in the Senior Phase
- establish the relationship between credits and time and conceptual loads
- link credit accumulation to progression and integration (for example practical work in the natural sciences, etc.)

3. An implementation working group had to produce a macro implementation strategy and framework plan. This would form the plan from which detailed operational plans would be developed by provincial departments of education.

The rational choice for the working group was a small number of 'experts' working hard at streamlining the curriculum. The Natural Science Working Group had five appointed members and a chairperson who represented the working group at task team meetings that involved chairs from all the working groups, members of the MPC as well as the foundation phase and transversal working group. Members of the MPC were attached to each of the working groups as mentors to the group. There were two mentors to the Natural Science Working Group. In December 2002, after the public input, four advisors were added to the Natural Science Working group. The management plan for the advisors was that each had to consult on particular content coverage and make special contributions one was to consult on science in the Foundation Phase and make contributions to cognitive development and language in that phase; the second had to contribute in the content area of life sciences and to examine implications for curriculum and teacher development; the third to advise in the content area of physical and earth sciences and to examine implications for curriculum and teacher development; and the fourth to consult in the area of life sciences as well as to contact organizations dealing with environmental education, human rights and new research in indigenous knowledge.

Of the six members (including the chair) in the working group and the four advisors added to the group seven were males and two females. They brought in a range of expertise from professions like consultants, subject advisors and university lecturers.

Altogether there were 12 individuals involved directly with conceptualizing and writing the policy documents for this process (chair, five working group members, four advisors and two mentors). Table 3 profiles four of the members of the working group, the four advisors and the two mentors. Despite many attempts I was not able to get a response from two other members that were part of the working group. Appointments to the position were done through nominations, interviews and a formal appointment, unlike the C2005 process that comprised of interested individuals.

Table 4.3: *Profiling the policymakers of the RNCS process by profession, teaching subject area, level of schooling of interest and experience of curriculum development in years*

Policy writer/maker	**Profession then**	**Teaching Subject Area**	**Level of Schooling of interest**	**Experience of Curriculum development at policy level in years**
1	Chair of SAASTE	Biology	Grades 1-9	16-20
2	Subject Advisor	Natural Science Botany Biology	Grades 4-12	6-10
3	NGO	Physic/Chemisty	Intermediate to senior	16-20
4	University Lecturer	Natural Science	Tertiary	More than 20
5	Subject advisor	Natural Science Biology Botany Zoology Environmental education	Grades 4 to tertiary	6-10
6	Science Education Lecturer at CASME	Natural Science	Grades 4 to 9	6-10
7	Lecturer	Physical Science Biology	Tertiary	0-5
8	Curriculum developers at NGO	Physiology Biology Phase specialist	Grades 1 to 9	0-5
9	Service provider/MPC/ Review Committee LAC	Natural science Botany Zoology Physics/ Chemistry Biology	all	6-10
10	University lecturer	Botany Zoology	Grades 4 to tertiary	11-15

Table 4.4: Profiling Policymakers of the RNCS process by gender, experience of teaching science at school, qualifications, the institute/organization they represented and their role in the process.

Policy writer/ Maker	Gender	Experience of teaching science in years	Representation	Qualifications with specializations	Role in the Process
1	Male	Under 10	SAASTE and KASTE	B.Sc (Botany and Zoology) UED (Botany and Zoology) B.Ed, M.Ed (sc ed cum laude) D.Ed (sc ed)	Co-ordinator-working group
2	Male	11-15	None	B.Sc (Botany, Microbiology) M.Ed (Sc ed)	Member- working group
3	Male	11-15	Sethlare	B.Sc (Maths and Physics) Med	Member working group
4	Male	11-15	Tertiary	BA (Psychology and English) M.A (Sc Ed) PhD (Curriculum and Instruction)	Member working group
5	Female	11-15	Cognition in Education group- Western Cape	D.Phil.Education M. Phil. Education B.Sc (Hons)	Advisor
6	Male	Over 20	Public Mandate for environmental education	B.Sc with Zoology 3 and Botany 3, B.Sc (Hons) in Zoology, Med in Zoology, second degree in teachers diploma, Med in EE, registered as a PHD student.	Advisor
7	Male	Under 10	None	B.Sc (Biochemistry and biology) STD (general science and Maths) Advanced Adult Education Diploma (adult instruction and curriculum development) Med (Science Education)	Advisor

Policy writer/ Maker	Gender	Experience of teaching science in years	Representation	Qualifications with specializations	Role in the Process
8	Male	Under 10	None	B.Sc (Chemistry and Applied Maths) T.T.H.D (High school physics and Maths Credential) research, sc ed)	Member –working group
9	Male	Under 10	Steering Committee for Association of science and technology educators SYSTEM (Students and Youth into Science, Technology, Engineering and Maths) National Centre for curriculum research and development (DOE) Further Education and Training Directorate	M.Ed (Sociology of education) B.Ed B.Sc U.E.D Maths and Physical Science B.Sc (Chemistry & Biochemistry)	Mentor
10	Female	16-20	N/A Member of the MPC	B.Sc (botany and zoology) B.Ed, M.Ed, D.Ed	Mentor Member of MPC Department official

4.3.6 Sample of Policy Documents Analysed

Data was also collected from in-depth analysis of science curriculum policy documents using two organizing constructs: the form of the policy documents and how the content of science, ideology in the notion of scientific literacy and the rhetoric governing scientific discourses was addressed in each of the documents for the C2005 and the RNCS processes. Data from the interviews and questionnaire was used to enrich the document analysis. It can be argued that the curriculum/syllabus documents provide the boundaries for what will happen in the classroom. Unless these documents represent the potential that exists within science and technology for contributing to child development then the potential will not be realised in the classroom. This will be the case even if the classroom teacher has a broader understanding of science and technology than is represented in the curriculum/syllabus. The teacher's understanding will, however, have a major impact on the realisation of the potential.

Table 4.5: Summary of the document analysis process

Aspect of Analysis	Documents and Number
Form	1) C2005 in the eight learning areas (LLC, Technology, MLMMS, HSS, NS, AC, EMS, LO).- 8 documents 2) NCS in the eight learning areas – 8 documents
Content and Ideology in conception of scientific literacy	1) Curriculum Policy Documents for Natural Science: (C2005 and the RNCS- 2 documents)

According to Merriam (1988), documentary data are particularly good sources for qualitative studies, because they can ground an investigation in the context of the problem being investigated. Analysis of this data source lends contextual richness and helps to ground an inquiry in the milieu of the writer. The data extracted from document analysis as the basis for more in-depth questioning of policymakers through semi-structured interviews to elicit from them what they see as the goals and agenda for inclusion/exclusion of particular kinds of scientific knowledge and conception of scientific literacy in the natural science curriculum.

4.4 Section Three: *Analysing the data*

4.4.1 Immersion/Crystallisation as an analytic style

In this section I will present decisions made about how the textual as well as statistical data was analysed and presented. Miller & Crabtree (1992) have identified 'four idealized analytic styles' based on these core steps: immersion/crystallization, editing, template, and quasi-statistical. Depicting the many diverse qualitative analysis traditions into these four categories simplifies the language without losing the core meaning. In the analysis of the data, I sought not so much 'triangulation' of ideas but 'crystallisation' – statements from one or another interviewee that seemed to bring together various pieces of evidence (from a number of interviewees) in ways that captured the meaning of that evidence. I was not present at the meetings and could not obtain first hand data on how the process unfolded. I had to search in the area of clinical research to construct the concept of immersion/crystallization. In immersion/crystallization, the three core steps are collapsed into an extended period of intuition-rich immersion within the text (Moustakas, 1990; Stein, 1990). It is the interpreter, as an editor, who serves as an organizing system in the editing style (Addison, 1992; Crabtree and Miller, 1992a; McCracken, 1988; Strauss and Corbin, 1990; Willms, Best, Taylor, et al; 1990), whereas an open-ended template or codebook is the organizing system for template analysis (Crabtree and Miller, 1992b; Miles and Huberman, 1984; Spradley, 1979, 1980.)

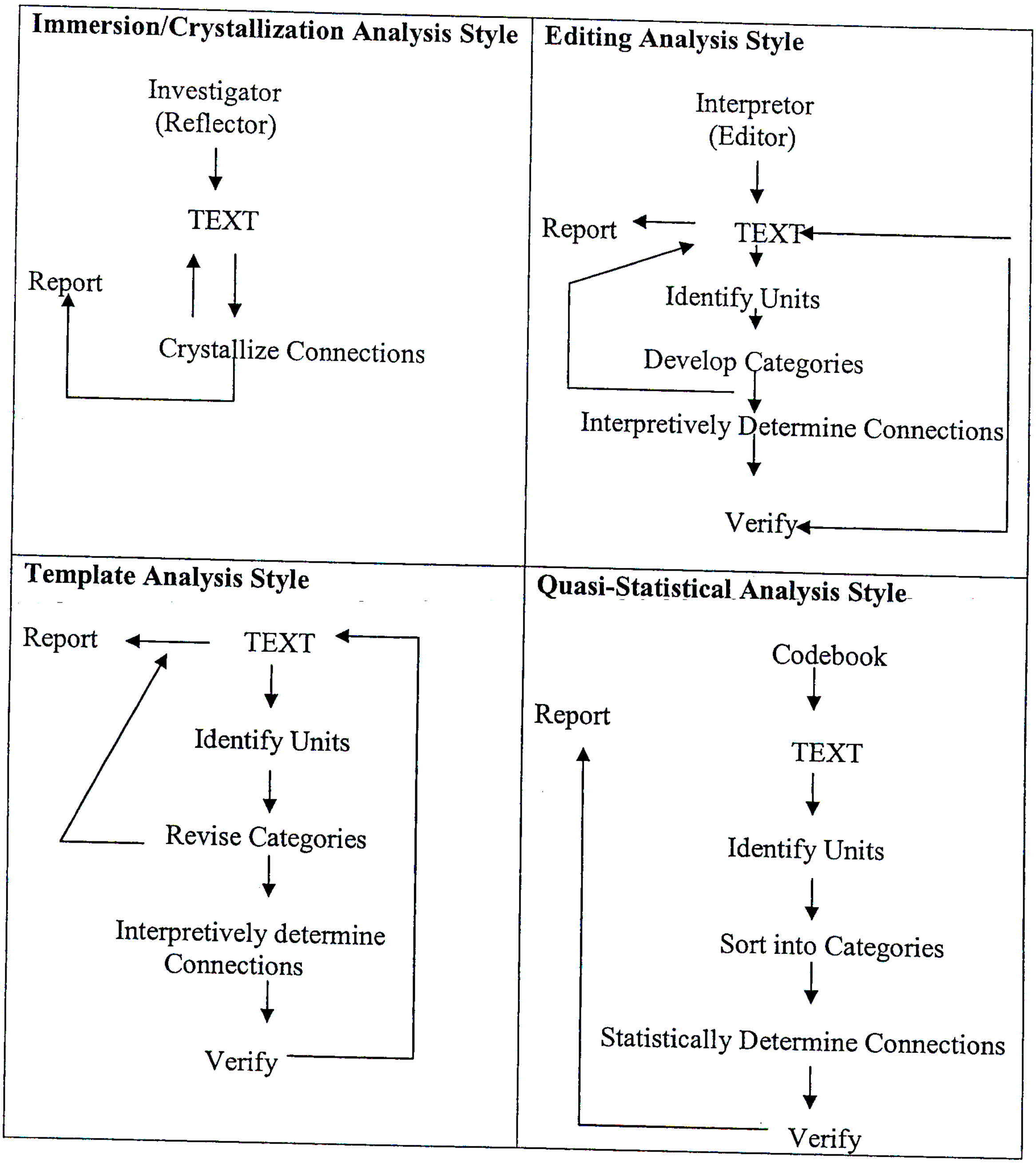


Figure A: Diagrammatic Representation of Different Analysis Styles
(Source: Crabtree & Miller (1992b).

How does one pick which analytical style to use for a particular research topic? Fig B presents an analysis space that includes a horizontal continuum of the four analysis styles representing the distance the analyst is from the actual text. This continuum reflects the structural rigidity of the organizing system. The vertical continuum represents the use of a specific analysis filter through which the text material is perceived. Some of these filters are very specific and explicitly limits what can be perceived in the text given the particular style used, whereas other filters are more porous and leave the analyst open to much more of the text-as-it-is. For example, traditional ethnography (TE), which uses the outline of cultural materials (Murdock, Ford, Hudson et al; 1950) as its perceptual filter and thus a carefully designed screen, is low in the space but within the editing style (see Crabtree and Miller, 1991, 1992a), which is on the more open spectrum of distance from text. Hermeneutics (H), through the process of bracketing, seeks to open the analyst to maximum experience within an editing-style relationship, and thus uses a more perceptual filter (Addison, 1992; Allen and Jenson, 1990).

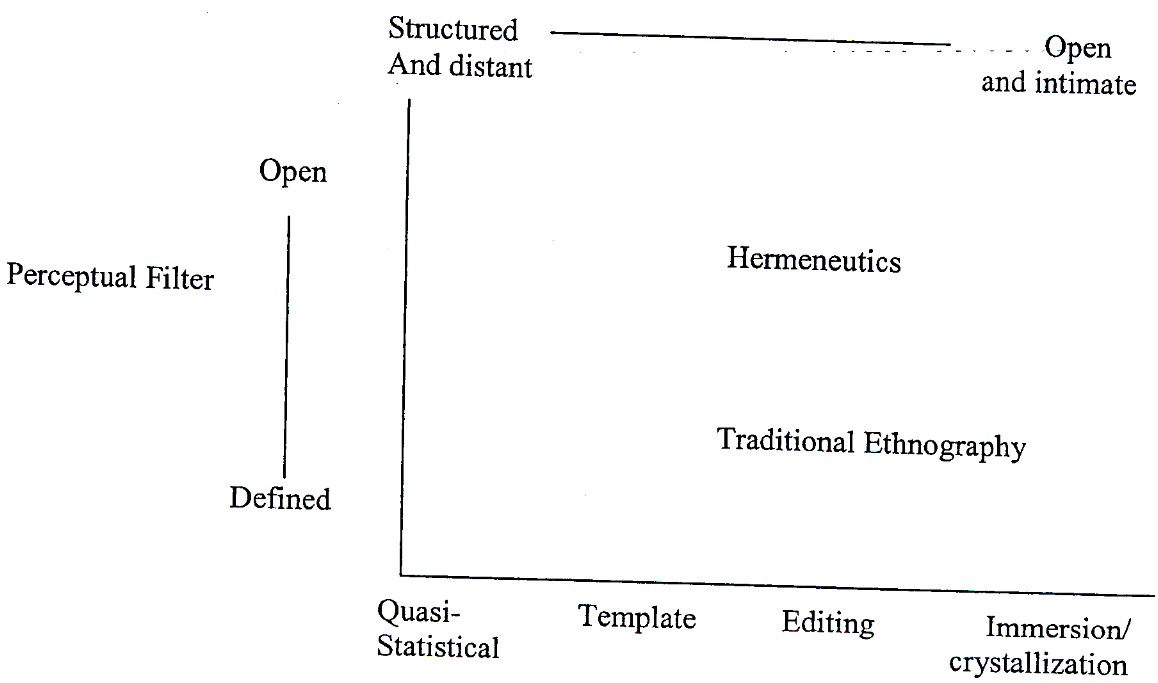


Fig B: *The Analytic Space: Diagrammatic Representation of Two Continua for Qualitative Analysis Strategy (Source: Denzin & Lincoln, 1994).*

The analysis space, similar to the understanding of naturalistic inquiry presented by Willems & Rausch (1969), is used to design the analysis approach. Denzin & Lincoln (1994) suggest four such approaches. First, the researcher must examine the questions and aims of the research. If the goal is exploration, discovery, or seeking to understand the experience of others, then the analytic method keeps him or her more open and intimate with the text. If the goal is theory testing an approach involving more structure then distance from the text is desirable. A second consideration is the amount of knowledge already in hand about the subject or question of interest. If there is much existing literature, especially qualitative literature, then more structure and distance is beneficial. If theory is explicit and well established in the area of inquiry, then using an approach with a more defined filter is helpful. A third consideration is design coherence with the data collection technique. For example, observational data, already filtered by a note taker, might be analyzed better using methods with a more defined perceptual filter, whereas analysis methods with a less defined filter are preferable with in-depth interview data. The operating paradigm also affects the researcher's approach to analysis. Materialistic inquiry calls for a more structured relationship with the text and a more defined perceptual filter, because control, prediction and consistency are valued. Constructivist inquiry, on the other hand, is iterative, and the analysis approach often changes through the collection/analysis cycles and needs to remain open to emergent experience and design (Denzin & Lincoln, 1994).

4.4.2 Analysing Documentary Evidence

Documents are "products" like speech itself, of a system within which they are defined and made meaningful. Documents so defined are converted into "texts" to be read and interpreted (Foucault, 1973:47). The impact of independent and exogenous variables on the meaning, content, or structure of documents, and their validity and reliability, becomes a background, whereas the foreground is the relationship between the 'text' as a social construction and its form or its important audience –derived meanings (for a more in-depth discussion of policy as 'text' refer to Chapter 3). Aside from the methodological problems associated with any qualitative technique (sampling, generalization, validity, especially external validity and reliability), content analysis has been unable to capture the *context* within which a written text has meaning. The un-decidable or the uncertainty in meaning that arises from changes in context is an irreducible and given in all texts. This necessitates other forms of data collection so that textual data become more meaningful and located. One must accept the difficulty of reading intentions from speech acts or texts and eschew final answers through philosophical analysis. Formal modes of meaning cannot be forced into simple matrices based on a series of binary oppositions. The 'irrational' has a new place in analyses of political myth (Barthes, 1972).

Poststructuralists urge careful reconsideration of written texts and their formulation, constitutional and conventional interpretation. To some extent, because of the conventional canons of interpretation reflect dominant values (and writers), they obscure the virtues of writers, ideas, perspectives and values deemed marginal. In this sense, post-structuralism turns attention to the margins and reverses the usual adherence to dominant cultural values. A text, in post-stucturalist terms, is not an object or thing, but an occasion for the interplay of multiple codes and perspectives. One must seek to and examine the operations or means by which meaning is conveyed (Derrida, 1976; Kristeva, 1980:37). Any writing contains multiple codes and times and may even frame other writing within it (Barthes, 1975). Once the field is a text itself, the previous anchoring of anthropology and sociology in 'facts' and 'data' vanishes, and authors speculate about fundamental issues of epistemology (Tyler, 1987); literary forms and genres (Atkinson, 1990, 1992; Geertz, 1988); the senses arise as themes (Stoller, 1992) and individual speakers disappear into discourse patterns (Moerman, 1988). Post-structuralism is therefore much more difficult (than philosophical hermeneutics) to characterize because it has taken diverse forms and many of its representations deny the very possibility of any clear and fixed characterization of it (or of anything else).

4.4.3 Analytical Constructs

In analyzing the data I used a mix of epistemologies in an attempt to theorise notions of scientific literacy. In addition scientific literacy has its own epistemology. I have explored three dimensions of ideology (chapter 2), policy analysis (chapter 3) and scientific literacy in (chapter 2). The concern here is with the task rather than theoretical purism or conceptual niceties (Ball, 1994b). The task then is to bring to bear those concepts and interpretive devices that offer the best possibilities of insight and understanding. The use of the concept of 'ideology' lends itself towards a philosophical and sociological interpretation of science education's aims, contexts and possible effects. Ideologies have impacts: they structure perceptions, legitimate and promote patterns of action, worldviews and values (Fourez, 1988), ideologies are demonstrated in behaviour or conversation (Cross, 1997), they can influence people's worldview, they can regulate or influence a discourse, what is said and the manner in which it is said, and influence interpretation of utterances (Knain, 2001).

Historical accounts of education, traces the process of educational change and expose the possible relationship between the socio-educational present and the socio-educational past (Kincheloe, 1991). Policy historiography asks three broad questions:

(i) What were the 'public issues' and 'private troubles' within a particular policy domain during some previous period and how were they addressed?

(ii) What are they now, and

(iii) What is the nature of change from the first to the second?

Critical policy historiography adds a further two:

(iv) What are the complexities in the coherent accounts of policy?

(v) What do these reveal about who is advantaged and who is disadvantaged by these arrangements?

Policy archaeology asks:

(i) By what process did a particular problem emerge (i.e., how did a particular problem come to be seen as a problem?)

(ii) What makes the emergence of a particular problem possible?

(iii) Why do some problems become identified as a social problem and other problems do not reach that level of identification?

(iv) By what process does a social problem gain the gaze of the state, of society and thus, emerge from a kind of social invisibility into visibility?

Policy genealogy seeks to ask:

(i) how policies change over time

(ii) determines how the rationality of the policy production might be problematised, and

(iii) how temporary alliances are formed and reformed around conflicting interests in the policy production process

In Chapter 3, I present a more in-depth, methodological framework for the analysis of policy. The analysis is now infused with constructs of ideology and scientific literacy from Chapter 2, i.e., the study is not only framed by critical policy analysis as research methodology but the account is presented through a story-line of ideologies that framed and informed the conception of scientific literacy. Scientific literacy as a concept is abstracted and universalized, with the 'contents' of scientific literacy becoming an end in itself. The concept implies that students will do more with their knowledge than build it into a classroom discourse removed from experience outside the classroom- students are expected to use scientific literacy as part of their lives (Malcolm, *personal conversation,* October 2003). I map the analytical field in the diagram below:

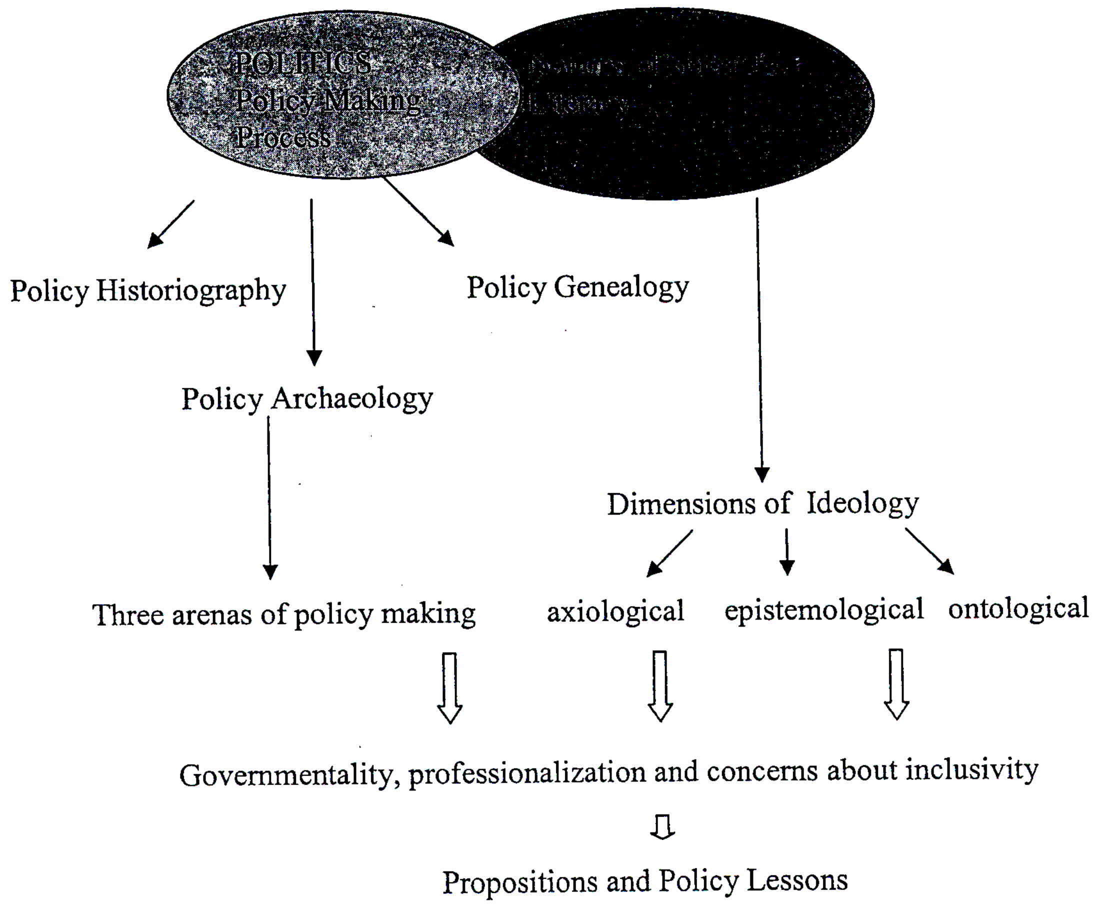


Figure C: Analytical Style of this study

4.4.4 Establishing Validity

Traditional descriptions of the role of the academic researcher stress such qualities as detachment, objectivity and impartiality. They also emphasize methodological rigor, respect for evidence, care in the analysis and interpretation of findings and caution in drawing conclusions. On this account, the researcher is a clinical scientist committed to an unbiased search for truth. Foucault (1981) challenges the assumptions underlying this account:

> *Each society has its regime of truth, its 'general politics' of truth: that is, the types of discourse which it accepts and makes function as true; the mechanisms and instances which enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true (Foucault 1980: 131).*

The implication of this statement is that an understanding of how knowledge is produced, and the value that is attached to it, cannot be separated from an understanding of the exercise of power. Indeed, Foucault (1979) goes so far as to propose that 'we should abandon a whole tradition that allows us to imagine that knowledge can exist only where the power relations are suspended and that knowledge can develop only outside its injunctions, its demands and its interests'. He goes on:

> *We should admit rather that power produces knowledge . . . that power and knowledge directly imply one another; that there is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute at the same time power relations . . . [I]t is not the activity of the subject of knowledge that produces a corpus of knowledge, useful or resistant to power, but power-knowledge, the processes and struggles that traverse it and of which it is made up, that determines the forms and possible domains of knowledge (Foucault 1979: 27-28).*

Academic researchers, on this analysis, cannot claim to be speaking from a position of being outside power. They have a professional role, acknowledged by the society in which they live, usually validated by a public institution (the university), which in turn exists because it is deemed to represent important values. All of this requires the exercise of various forms of power (political, bureaucratic and economic) that serve to authorize the kinds of activities in which researchers engage. The interests that these activities serve thus extend well beyond the intellectual pursuit of 'truth'. The search for clarity and simplicity of meaning is seen as illusory because there are always other perspectives from which to interpret the material under review. To seek a definitive account is, thus, a misguided undertaking. Foucault raises disturbing questions for researchers working in policy-related fields. While policymakers have to take decisions within restricted time frames, as far as researchers are concerned there is never a point of final closure. There is always the possibility of going back to first principles, re-analysing the data, incorporating new evidence, applying different interpretative indeed the very concept of researcher presupposes such intellectual open-mindedness (Humes and Bryce, 2003). Researchers have to learn to live with the confusions, ambiguities and value conflicts of the postmodern world as best they can: the notion of the intellectual as a detached enquirer after truth, operating outside the forces of power, has been shown to be a self-deceiving (and, in many cases, a self-serving) illusion. The antidote to this illusion involves several forms of practical and theoretical engagement: immersion in problems identified by educational practitioners in a wide range of contexts; professional dialogue with stakeholders from within and beyond the world of education; and involvement in political processes that serve to challenge the dominant configurations of knowledge, power and discourse (Humes and Bryce, 2003).

In this study I was not preoccupied with the representatively of research (external validity), as I made attempts to involve the whole population of policy writers in the Natural Science curriculum development process. The policy documents were also analysed in their entirety. In the narrative I provided slices of interactions and experiences, located people in specific situations, brought interactions alive between two or more people as well as provided a detailed rendering of how people felt (extracted from interview transcripts and the questionnaires). By providing vivid detail the readers are helped to understand that the account is credible. This also enables any reader of the research report to choose the degree of distance between the context being described and his/her own context. The choice is left up to the reader to decide whether to transfer ideas, insights or interpretations across into their own contexts.

I employed several other strategies to enhance the validity of study. Firstly, I piloted my questionnaire to two policy writers. This validated the research instruments to be used, and informed the overall research design strategy. Secondly, I made use of multiple sources of evidence, which allowed me to address a broader range of procedural and perceptual issues. However, the most important advantage presented by using multiple sources of evidence was the development of putting together the pieces of the story (see crystallization in section 3.1). I sought not the process of triangulation. Thus by using this particular research design the findings or conclusions are likely to be more convincing and accurate since it was based on several different sources of information, following a corroboratory mode. Thirdly, I took the data and interpretations back to the participants so that they could confirm the credibility of the information and the narrative account that I presented. With the lens focused on the participants, I systematically checked the data and the narrative account. This was done by requesting of the participants to view the raw data (i.e., transcriptions), and to comment on the accuracy. Fourthly, I requested a colleague who was involved with policy research and who was familiar with the research to serve as a sounding board for ideas as well as to provide written feedback after reviewing the data and research process. The main function of the peer reviewer was to provide support, challenge my assumptions and ask hard questions about the methods and interpretations I used during the entire duration of the study. Given the post-structural account of validity I make no illusions of coming to 'the truth'.

Data processing and analysis

Approaching the data analysis from an interpretive perspective, I offer some insight into how I had conducted both surface-level and deep structure analysis. I transcribed all interviews. Responses to particular questions were transcribed in brief narrative form. Responses from various interviews were also compared and categorized as well as patterns and trends were identified, divergent responses and possible explanations recorded. This information was crosschecked with data generated through the analysis of policy documents, and the questionnaire. The qualitative and quantitative data was analysed manually due to the small population of respondents. The policy lessons (see

Chapter 9) emerged from the analytical framework I outlined above, i.e., an inductive approach.

Prior to data reduction, i.e. coding data in preparation for analysis, the questionnaires were edited. Three tasks central to editing, which Moser and Kalton (1977) refer to, were carried out: (a) completeness (a check to make sure that there is an answer to every question); (b) accuracy (as far as possible, a check to ensure that all questions have been answered accurately); and (c) uniformity (a check to ensure that all respondents interpreted the questions uniformly). I had the opportunity of following up telephonically on questionnaire items in cases where the information was lacking or incomplete. Policy documents were also analysed in accordance with the analytical framework sketched above.

4.5 Limitations of the Study

4.5.1 The power(ful) and the power(less)

Policy research aims to unravel the complexities of the policy process, a task for which qualitative methods are more appropriate. There are challenges that accompany the pursuit of qualitative methods that are related to the politics of research. Qualitative approaches within policy research require access to key players in the policy process who are often powerful politicians, political advisors and senior bureaucrats (Taylor *et al,* 1997). Questions of access to such people can become an issue, particularly for students conducting research. In the South African case, in attempt to involve as many and as inclusive a stakeholder representation of the population as possible, access to people involved in writing the science curriculum policy documents became a logistic issue as they were located far and wide. In addition, policymakers are busy people and to agree to a time and place for an interview did create problems. I had to resort to telephonic interviews in some cases. In addition to logistical access, the researcher's presence in the interview situation (particularly policy research where influential and powerful people are the interviewees) has been highlighted by feminist researchers for some time (Roberts,

1981) and lately been raised within the general qualitative literature (Le Compte *et al*, 1992). Ozga and Gewirtz (1994) have written specifically about their experience as women policy researchers interviewing past and present senior policy makers. People being interviewed will provide an account from a perspective that may include a distorted or magnified/glorified perception of their role in relation to a particular policy. The reverse may also be true where because of their inherent personalities and a penchant for humbleness, policy makers may gloss over their powerful and influencing role in the process. For this reason it was important to access as many accounts and sources as possible in order to move towards a complete and as 'true' a picture as possible. There are also ethical issues to do with the anonymity of informants and confidentiality of the information they provide. Policy writers have acquired a particular 'speak'. How does one mask this in the interest of anonymity? I found this a difficult, daunting and yet a challenging task to camouflage this and not expend on the quality and richness of the data.

4.5.2 Seeking Conceptual Purism

In defining any concepts, the challenge is to define the concept so as not to present any ambiguities in its understanding or meaning. This is different from a conceptual framework, where one selects particular constructs for understanding what a concept means and allows this definition to inform data collection and data analysis. The concept of 'policy maker' posed one such challenge. Is the policy maker an agent of the government? What is the extent of an individual's involvement in the policy production process and what role does such a person play in formulating a policy? What term is used to name those individuals that do the actual writing of the policy? There are clearly varied domains of policymaking. It is for this reason that I have referred to the individuals involved in writing the policy document (at whatever level) as 'policy writers'. Another conceptual area that posed a challenge is 'content'. I had to clearly differentiate between the content of the policy documents (what is in the policy document) and content as in subject (disciplinary) knowledge, which I refer to as 'conceptual knowledge' in this study.

4.5.3 Seeking analytical closure

I am reminded here of an address by a Professor of Maths Education at the University of KwaZulu Natal who in an address during the launch of the University's doctoral programme said:

> 'doing your PhD means coming to terms with your ignorance' (05/03/2004).

My promoter and I have been engaged in a desperate search for theoretical constructs that would best illuminate the policy process- or one that one shed the most insightful light on the data. Personally, I have been constrained by my intent of looking for a particular set of constructs, from one particular theory. My analysis is grounded in the increasing acknowledgment of the benefits of 'theoretical eclecticism' (Cibulka, 1994; Ball, 1997; Taylor, 1997; Ozga, 2000), on the assumption that combining theoretical perspectives offers complementary analytic 'tools', and therefore a more 'complete picture' than any one theory alone. The prospect of an open intellectual landscape with no distinctive or defining features is suggested. That is exactly what I present in the chapters that follow: a toolbox of constructs that best illuminate the study. I may not have all the answers, the analysis that I present may appear complex and messy, but my journey through this process has enabled me to link these constructs in the best (and possibly unique) way that I could through traveling through this theoretical landscape.

4.5.4 Literature in the field on policy analysis and attempts to operationalise the process

The literature on analyzing the policy process, although vast, does not provide methodological tools to operationalise the policy process. Recently, critical approaches to educational policy studies have been subjected to increasing interrogation over methodological issues, often by critical policy researchers themselves (Gale, 2001). The literature on critical policy analyses offer few critical accounts and connections between the stories they tell about policy and the data used to tell them. Gale (2001) has usefully illustrated through policy historiography, policy archaeology and policy genealogy questions that could be asked in the interests of the 'what', 'how' and 'why' of policy. I also draw on the work of Scheurich (1997) in policy archaeology where he presents an illuminative account, through four arenas of policymaking, how the policy process can be constructed.

4.5.5 Clarifying purposes for policy analysis and discomfort with the critical stance

What I have done in this study may not be strictly 'policy analysis' (see Chapter 3), but I have been extremely uncomfortable with taking a critical stance. What to look at is related to the researcher's political disposition and disposition in general. I am also reminded that the master's tools will never dismantle the master's house. Critical policy analysis is informed 'by the conviction that "things'', especially policy discourse, must be pulled apart' (Troyna, 1994: 71) to determine whose interests they serve. My discomfort was with the 'interest' that is being served. The implication is that this is hidden and negative in connotation and needs to be unmasked. I have been troubled by policy writers serving the process as best as they could, in an altruistic sense rather than to serve particular interests. My concern is with the subject of the narratives, i.e., what is included in these 'stories' about policy (and what is not). In some ways, Scheurich (1997) conception of policy archaeology has helped me resolve this discomfort (see Chapter 7 on professionalisation).

4.5.6 Contact details and Records

Pre 1994, the control of curriculum and its development was under nineteen different ex-departments. Some syllabi were as old as twenty years and there were no proper records kept of who was involved in writing those documents. I had to subsequently tailor my study to collect empirical data only for the C2005 and the RNCS processes. For the C2005 process, there were no formal records kept of individuals involved in the process of policymaking, especially at the level of the National LAC. I had to use a snowballing effect and did manage to locate about seven of these individuals. Fortunately, the RNCS process was formalized and there were records kept of individuals in the working groups and special interest groups. This information was also freely available on the Department of Education's website.

4.5.7 Tracing a trajectory- rely on the failing memories of policy writers

The inherent problem of using human subjects, and particularly in tracing a trajectory of a policy development process, is that the data refers to a period of many years (in this case seven years) and is susceptible to failing memories. I was not present at these meetings and could not capture the nuances of the process. I had to rely on the memories of those involved, and to obtain a comprehensive an account as possible from various sources so as to put the pieces of 'evidence' together that lent credibility to a policy moment. I have used crystallization as an analytical tool to provide a coherent account of the process.

4.6 Conclusion

This chapter opened the window into the research practices I engaged in during the course of my study. The data collection instruments and procedures for data collection were described in detail followed by an in-depth presentation of data processing and analysis procedures. I also infused this description with critical reflections on the research process and my role as a researcher.

In Chapter 5, I begin the first level of analysis.

Chapter 5

Unmasking Shifting Ideologies in the Conception of Scientific Literacy

> *In an African culture, artificial distinction between the social and the economic or between the economic and personal is non-existent. Such an artificial distinction was imposed through a systematic socialization of "separate education". The new science curriculum is underpinned, among others, by the principle of human rights and inclusivity. These principles ensure that the science curriculum is inclusive and contributes to nation building. A nation that is defined by the constitution to be non-racial, non-sexist, multi-faith, multi-lingual, free, responsible, equitable, at peace with itself and promotes unity in diversity. Such a science will, in polity terms, be able to reconcile the perceived social/personal and economic tensions. In practice, those involved in the implementation of such a science must be equipped with knowledge and skills to develop learning programmes that will attest to such a policy* (Department Official and Policy writer A- C2005 and RNCS).

5.1 Introduction: Enter the Science Team

In Chapter One, I mapped out the context for curriculum reform as it unfolded during the different periods (pre-1994, 1994, C2005, the Review process and the development of the RNCS). In this chapter I will trace the historiography of policy reforms and how ideologies in the conception of scientific literacy have shifted for the C2005 and the RNCS processes. I write this chapter in mini-vignettes where one of more policy writers' views is crystallized (see Chapter 4). Recall, from the discussion in Chapter 3 that historical accounts of education traces the process of educational change and expose the possible relationship between the socio-educational present and the socio-educational past (Kincheloe, 1991). Policy historiography asks three broad questions:

(i) What were the 'public issues' and 'private troubles' within a particular policy domain during some previous period and how were they addressed?

(ii) What are they now, and

(iii) What is the nature of change from the first to the second?

Critical policy historiography adds a further two:

(iv) What are the complexities in the coherent accounts of policy?

(v) What do these reveal about who are advantaged and who are disadvantaged by these arrangements?

I take as my point of entry for this chapter the larger debates that have led to the conceptualization of the C2005 process. Before C2005 the content of the science policy documents were consistent with the major international reforms of the 1960s, but aware that so few schools had labs and qualified teachers, it was largely concept-based and abstract, drawing its structure from the structure of the disciplines of Physics, Chemistry and Biology. In this structure, Physics Chemistry and Biology are more basic than meteorology, oceanography, metallurgy, earth science, and within Physics for example, electric charge was more basic than electric current. The underlying philosophy of science was the concept of pure science, where scientists had moral responsibilities to truth (in an essentially positivist framework) but whose desires for truth were presumed to set their work largely outside broader social and economic life. Syllabuses and textbooks were derived largely from UK and US or were written largely to reflect the US and UK experiences. It was in the sixties that Science Education emerged as an international discipline of research and development – perhaps under-laid by an assumption that science education, like science, was essentially universal, and because of the resources that the US and UK had available, they provided the leadership in curriculum thinking. No attempt was made to include or consider other experiences e.g., African experience (except in details such as the choice of organisms in Biology or a description of the context in which western concepts could be learnt) and other cultures; science offered 'tested reliable knowledge' that was superior to other ways of knowing, and was best considered as an independent system of thought. This also fitted well with the Apartheid agenda. The 'myth' of the sixties curriculum – mostly intended to expand the talent pool for employment of scientists, and to increase public support of science – was that this kind of discipline-based science was good for everyone.

It is against this backdrop of macro curriculum policy reforms and the development in science specific reforms that this chapter unfolds. The chapter is organized around the three processes so as to lend continuity the process of curriculum reform. Data for the C2005 and RNCS processes has been gathered from interviews with individuals in the writing team and those individuals in the management of the process that had an influence on the writing team, as well as the C2005 and RNCS policy documents. For the review process, curriculum issues in general were addressed and selected interviews were conducted with the policy writers by the review team, for e.g., in the science writing team policy writer B was interviewed. Data for this part of the process is mainly that of the Chisholm Review Report.

Section 1

In this section I document the issues that have shaped policy choices and how the outcome of these choices is reflected in the policy document for C2005. The section is organized broadly into two parts: part one documenting the issues and troubles at the time and part two with how these are reflected in the notion of scientific literacy. I conclude this section by drawing out the key influences or ideological shifts on the notion of scientific literacy. Ideologies are defined in Chapter 2 to include ideals, values, worldviews and philosophies.

5.2 The C2005 Process

5.2.1 What were the public issues and private troubles for the Science Writing Team during the C2005 process?

The world today is undergoing a dual movement of globalization and fragmentation. It is also being shaped by progress in scientific knowledge and technology. There is an increased emphasis internationally that make the current reform visions significantly different from previous efforts: nature of science and scientific inquiry. Helping students develop adequate conceptions of the nature of science (NOS) and scientific inquiry has been a perennial objective in science education (American Association for the Advancement of Science [AAAS], 1990, 1993, National Research Council [NRC], 1996). Presently, despite their varying pedagogical or curricular emphases, there is strong agreement among the major reform efforts in science education (AAAS, 1990, 1993; NRC, 1996) about the importance of enhancing students' conceptions of the NOS and scientific inquiry. In this part of the chapter, I explore what policy makers perceive as the reasons for reforming the science curriculum.

Why was there a need to reform the science curriculum?

Data gathered during interviews and the questionnaire reveals that science curriculum reform for C2005 was underpinned by the broad transformational movement of curriculum in all learning areas occurring in the post apartheid period. The Natural Science Area was not identified as a unique area where reform had to occur.

> *I mean irrespective of the kind of philosophy that underpins OBE the science was becoming outdated. That was one thing I think that was urgent and it should have happened anyway. The kind of global movement towards outcomes based education in various forms and you know the transformation that was happening in the country it was like a whole lot of things coming together and gaining momentum that might drive it through. (Policy Writer C-C2005)*

There was no contestation on the transformation agenda. The tidal wave of transformation and its agenda found public acceptance. Policy writers were not contesting the principles that framed the new curriculum i.e., learner centered-ness, outcomes based and integrated knowledge was widely accepted. There was also no question that the 'kind of global movement towards outcomes based education' was the direction that post-apartheid South Africa should move towards. Nevertheless within this global agenda there was amongst policy writers an awareness of the broad trends in science education reforms of the time (i.e., shifting to context based learning, thematic approach to concepts, inclusion of environmental and earth sciences conceptual knowledge, linking theory to practical and teaching underpinned by the broad base notion of constructivism, etc) and a determined effort to address the poor state of science education on the ground, as is evident in:

I think it was long overdue, the turnover time for curriculum revision prior to 1994 was supposed to be about five years, in reality it was a helluva long time. General science had just been reviewed, neither physical science nor biology had gone through. So we were then dealing with and still are as far as I know dealing with the 1984 syllabus. Now for a science to be twenty years behind what is happening (Policy Writer C-C2005)

and

> *You see the level we had time to work with. Everybody that was there basically said science education in South Africa is in a very bad shape. The majority of students are not doing well. Link this to the huge backlog that has happened, I mean the huge disadvantage that has been built up and so on. The lack of conceptual understanding, a lack of meaning in learning science, no vision beyond getting a matric, eh, a very instrumental view and so on. I think everybody was concerned about that (Policy Writer E- C2005).*

However, policy writer C-C2005 does not make explicit whether pedagogy should also be reviewed together with conceptual knowledge or should the underlying philosophy of science education be addressed? Also what is to be reviewed in disciplinary knowledge is not clear? Should the content knowledge be reviewed in light of 'updating' the science concept knowledge in relation to research over the past twenty years? Should conceptual knowledge be more rigorous based on strong disciplinary lines or should themes be integrated with the subject matter? Policy writer D-C2005 acknowledges drawing on *'current philosophy and thinking on education in general and science education in particular'* and how they could inform conceptualization of science education, the purposes of science, what kinds of conceptual knowledge should be included and how it can be contextualized, etc as is event in:

> *(There was a) need to address the skewed education system as designed under the apartheid era. Secondly, there was a need to have a curriculum that acknowledged current i.e., on a world scale, philosophy and thinking on education in general, and on science education in particular. I'm thinking of a whole lot of different levels. You know the need to conceptualise what science really is, what kinds of knowledge you are dealing with should be reflected in the broad curriculum as well, as well as predominant learning theories like social constructivism. You'd want to bring in material that is contextualised for learners, be more learner-centered as well as curriculum, what syllabus, what purpose does it serve in society, in the country? I'm sure the purpose needed to be broad, that includes ideas of scientific literacy for those who are not going to do more science after school, they need to know some basic, chosen things about this science.* (Policy Writer D-C2005).

Clearly there is an attempt to address the epistemology of science (*'what kinds of knowledge you are dealing with'*), the purposes of science and an interest in current theories of learning science like constructivism. Not alike the reform movements in the development of science education in the seventies policy writers also cited political, historical, economical and educational needs. There were movements of linking education with training and science could not be divorced from this. Also a need to recognize workplace learning, given that a vast majority of South Africans had limited access to formal schooling, that found a home in the NQF. Policy writer E-C2005 and Policy writer B-C2005 were part of earlier meetings where a lot of discussion revolved around these issues:

During the early 90s there had been quite a lot of discussion on the disjuncture between education and training so there were a number of people who wanted to see those two things linked again. There were also concerns that date back to the early 1980's that people in industry were on the job acquiring a lot of experience but it was never going to be acknowledged particularly in wage terms because there was no qualification to show for it and I think another concern was a linked concern, was a huge number of people who had gone almost through to matric but have been in school for 10, 12, 14 years and nothing to show for it. So the talk was of ladders that people could climb and there were parallel ladders. I don't think you can see the science curriculum apart from that whole political drive, portable credits, the NQF, on which you could get a science education whether you are in school or out of school, whether you were young or old. To do science, to do maths, to do everything else those were the concerns at the time (Policy writer E-C2005).

Curriculum was inappropriate to the needs of the country and its people, particularly in view of our history and the anti-apartheid struggle and the need to build a 21st century economy (Policy writer B-C2005).

And

Well I think there has been an enormous, such an orthodox view about our syllabuses. The way I always thought of it is quite hard to understand the extent of the South African science curriculum was outmoded. It probably representing in global terms, one of the main arguments is that the science curriculum is an outdated curriculum that hasn't been tampered with for so long and many of the curriculum say..... but we were sitting with a curriculum were the joke was that there was no one alive any more from those that had written it, it was reviewed, its got a little abridged version to it. It got reviewed, if I can remember in the early 80's curriculum was very much unchanged for a very long time, it was so out of date, so completely out of date, I mean there wasn't any contestation about wanting to change it. It was kind of accepted by everybody that it really had to change. No one was under any other view than it had to be quite extensively reworked. (Policy writer I- RNCS)

With regards to science education in particular Policy writer F-C2005 and Policy writer E-C2005 concur with the need to bring science education into current lines of reform, a plea for breadth… but these ideas are problematic: does breadth mean a superficial foray into the disciplines conceptual knowledge and skills or would it mean more rigorous conceptual knowledge leading to increasing levels of abstraction or integrating conceptual knowledge or possibly broadening the focus of science to incorporate science-related fields like technology?

Science curriculum had too narrow a focus. Much of the content was irrelevant to the lives of the learners. Skills were defined too narrowly, values were only acknowledged in the aims – never included in the syllabus and not promoted in the teaching and learning process and not always appropriate (Policy writer F-C2005).

and

I think it was a number of things. One was, of course, the earth science had had no real place in the old science curriculum, which is odd considering South Africa relies so much on mining. Another was the history of science or shall I say the social dimension of science, the philosophy had not been represented at all (Policy writer E).

Also, the inclusion of the earth sciences is in line with current international reform but the extent to which Policy writer E-C2005 considers it to be included for industrial, economic or contextual (making science localized) or all three is not clear. What is clear though is that there were many issues that needed to be addressed in the design of the curriculum, underpinned by the broad ideology of curriculum development at the macro level of policy making (i.e., learner centeredness, outcomes based, social redress and integration). These are, amongst others, the need to broaden the focus of science conceptual knowledge, skills, purposes, to include values and ethical considerations to science development, to recognize workplace learning, to align science education with current international thinking e.g., underpinned by constructivism, learner centered education, integration of conceptual knowledge across, and within disciplines and a building of a twenty first century economy that would be globally competitive. What is the interesting thing here is that no-one in these interviews was really questioning the basis in Physics, Chemistry and Biology: the changes in content that they anticipate are Earth Science, applications of science, fuller discussions of the nature of science and some [undefined] notion of African science. Policy writer E- C2005 makes oblique mentions of vocational education, also undefined. Beyond that, their concerns were largely about purposes, and pedagogy: context-based learning, problem-based learning, constructivism... In other words, their 'updating' was more about purposes (broad social purposes, detailed learning purposes) and curriculum design than curriculum conceptual knowledge. Next I will explore how the content of the policy document is shaped by current understandings of the nature and needs of science, the nature and needs of children, and the nature and needs of society as defined by the policy writers.

5.2.2 Ideological traces in the notion of scientific literacy for the C2005 process

a) Purposes

The preamble to the C2005 policy document states that in order for the document to make an effective contribution to education in South Africa the Natural Science Learning Area is committed to:

- *Broaden access to material, resources, knowledge acquisition and conceptual development*
- *Redress past imbalances*
- *Contribute towards socio-economic development and a better life for all; and*
- *Challenging the perception that science is predominantly a European discipline* (NS-2).[1]

These aims concur with the views articulated by policy makers. However the purposes of science was not made explicit in the C2005 document. However the document does state that:

> *The development of appropriate skills, knowledge and attitudes and an understanding of the principles and processes of the Natural Sciences enables learners to make sense of their natural world; contribute to the development of responsible, sensitive and scientifically literate citizens who can critically debate scientific issues and participate in an informed way in democratic decision-making processes; are essential for conserving, managing, developing and utilizing natural resources to ensure the survival of local and global environments; and contribute to the creation and shaping of work opportunities (NS-5).*

[1] NS-2 here indicates page 2 of the Natural Science Section of the C2005 document (DOE, 1997).
This analysis shows a strong humanist, multi-cultural and a socially critical view of learning in the introduction to this document. This view permeates the outcomes, the assessment criteria and range statements (see table 5.1)

It must be acknowledged that the policy document is a product of a number of debates and what is reflected in the document at face value may not capture the nuances of the discourses as what policy makers may articulate. Purposes of science can be inferred from the document e.g., Specific outcome (SO) 9 (*demonstrate an understanding of the interaction between the a Natural Sciences and socio-economic development)* speak directly to the broad transformational discourse of addressing inequity and making science accessible through producing scientifically literate individuals. The specific outcomes are clearly depicted in Appendix B. The interesting questions here are how C2005 feeds directly and indirectly into social and economic development....

The set of specific outcomes (see Appendix B) does a few things:

- It maps the field – it defines 'scientific literacy' as it is to be represented in the curriculum.
- It sets the learning purposes, in the form of demonstrable achievements. The outcomes are intended to objectify competences, not knowledge as such.
- To the extent that standards, or steps in achievement, must be defined for each outcome, the outcome indicates 'what progresses' as children reach the outcome.
- It articulates with the critical outcomes, and the overall purposes of the curriculum.
- It provides a useful framework for designing curriculum, teaching and assessment.

The nine SOs of C2005 overlap with each other in lots of ways: taken as axes in the 'space' of science education, they are NOT orthogonal/perpendicular for e.g., SO3 is related to SO1 and SO5. SO 7(*demonstrate an understanding of the changing and contested nature of knowledge in the Natural Science)* is a departure from the traditional conception of science as a body of *'immutable truths and therefore as absolute and without change'*(NS-20). This notion is also reflected in the rationale for the learning area: *'Learners need to know that science is a human activity, dependent on assumptions which change over time and over different social settings'* (NS-5). Also a departure from the Euro-centric conception of science is SO 6 (*demonstrates knowledge and* *understanding of the relationship between science and culture)*where science is value laden (also see SO 8: *'science cannot necessarily be seen as the only way of making sense of the world around us'* (NS-19). Implicit in this outcome is an exploration of underlying structures that underpins other forms of knowing. Also implicit in the outcomes is that knowledge is socially constructed (SO 2: *demonstrate an understanding of concepts and principles, and constructed knowledge in the Natural Sciences).* The outcome implies knowledge learned in context and a shift from a predominantly theoretical and abstract conception of teaching and learning concept knowledge. Hence at the level of the SOs there are clear attempts to create a definition of scientific literacy that fits with African culture and social transformation. However, these shifts are less clear in the specification of content (see part [*c*] *on conceptual knowledge).*

Recently there has been an increased interest in the goal of 'science for all' in most reform initiatives. The C2005 policy states that:

> I*n view of its potential to improve the quality of life, learning in the Natural sciences must be accessible to all South Africans (NS-5)*

Policy writers had varied views on how this goal could be defined, conceptualized and achieved:

> *Well certainly up to grade 9 level we kept to the idea that scientific literacy was important and that everyone would do science up to grade 9, so in that sense it was to be science for all because the purpose was to create literacy. You can't have science for all with the idea of preparation for academic studies at tertiary level. It would be silly, not everyone is doing that. ……the debate and the understanding was we talking about science for all here, so what should children in South Africa should learn in order to become literate about science* (Policy writer D-C2005)

Interestingly, this merely shifts the problem of 'science for all' to some concept of 'science literacy'. And yet, surely all science education advances science literacy? Underlying this view is that science for all cannot be achieved 'by all' past the GET phase. At this level the goal of science for all is to develop a scientifically literate citizen. Policy writer F-C2005 also articulates the need for a particular kind of citizenry but questions the definition and purpose of science for all as an inherently political act.

*We need to distinguish between what we mean by science for all and science education elsewhere and my understanding of science for all here .....science that doesn't necessarily directly put into tertiary careers in science but its more for citizenship – science that everyone can take and everyone can become scientifically literate where the science for all-the political pressures I'm referring to –comes out of a nation where science was very much a White thing-curriculum and that other racial groups were discriminated against in their science. I think you need to define what you mean by science for all (*Policy writer F-C2005).

And policy writer G links this goal with that of contextual learning/ localized science.

It was important. But during the discussions there were many ways, many good ideas about how this could be addressed. South African people in the cities were not science people in the countryside. There was a high level of awareness of appropriate science. That was a process into science for all. It was also very important that learners should be equipped with the tools and the skills so that life could be a lifelong learning process. And it was vitally important that these were positive happenings to come out of it (Policy writer G-C2005).

Policy writers were posed with the question where they were asked how they resolved the tensions between 'science for all' and 'science for elite'. The general view was that the focus in the GET phase was the development of 'science for all'. If a tension exists, it is perceived. Policy writer D-C2005 sees a place for both in the different stages of schooling. The goal of science for all is coupled with the development of scientific literacy "for all".

This relates in my mind to levels and purposes of education for different groups of learners. All learners in South Africa should develop a reasonable level of scientific literacy. Science for further study ('elite'?) at tertiary level for instance, should be available as well and be of the highest quality, well resourced and focused on sophisticated concepts, principles and theories as well as skills development well above the 'average' of scientific literacy. This is expensive in a number of ways (finance, human resources, time etc) and can only be available to a limited group (but I would not call it an 'elite') of people who have chosen to dedicate their intellectual and other capacity to the field of natural sciences or related fields (Policy writer D-C2005).

Policy writers C-C2005 and F-C2005 concur, but not at the expense of 'dumming down' the curriculum:

The GET phase should focus on Science for All. No need to resolve any tensions. This is simply not the place to specialize and no place for 'Science for elite'. This does not mean a mediocre form of science and levels of investigation can be adjusted for learners of different abilities in different classes (Policy writer F-C2005).

and

as long as you don't neglect one at the expense of the other, you need to provide for both. The science as a life skill, scientific literacy and then the science for the elite. Differentiate at the level of the learning site. (Policy writer C-C2005)

There is a clear articulation of a widely accepted view of scientific literacy, but what this is has not been made explicit. A distinction is made here at providing different kinds of science at different sites, linking closely with Policy writer D's-C2005 view of science not being accessible at all levels of schooling. Policy writer E-C2005 takes on a more pragmatic stance. His view is that despite the potential for science for all in a science curriculum the way in which science is taught will be the overriding factor that realizes the goal of 'science for all':

I will take an approach that values the important ideas in science, entitlement for all children, understanding why science is valueless, some of the big theories. I suppose discovery of it. Science for all is the content selected and taught in such a way that most children exposed to it have a chance of succeeding in it. What science is in there is not for all, its what you make sense of it. Many of the old education departments ended up saying no matter what the curriculum, the way it happens in schools – the science is meaningful for a very small percentage. I would distance myself from science for all and science for an elite, I think that what is important in meaningful learning for all children is to make meaningful choices from grade 9 whether they want to go on with science. Not surprisingly science is difficult, it is difficult to understand and if does want to follow the argument, I don't believe in the sort of journalist conception of science to be taught in schools. I think that's a waste of time. To get into the debates of science in society with very little understanding of what science is (Policy writer E-C2005).

In the past, the primary goal of science was characterized as seeking a coherent, systematic, unified theoretical understanding of the natural world, a view reinforced by early philosophers of science. More recently, however, expectations for what theories might accomplish in terms of systematicy and coverage of phenomena have been revised downward. Theories are increasingly being viewed more practically as `a loosely connected set of models', whose `range of application is not fully specified and whose effectiveness and accuracy vary considerably within that range' (Giere, 1988). In other words, most scientists occupy themselves trying to understand only how selected, highly circumscribed portions of the world work, not with developing a coherent picture of the world as a whole.

(b) Notion of Scientific literacy

The C2005 policy document

In articulating the definition of scientific literacy the document states that:

> *Scientific literacy involves the ability to apply scientific concepts and principles to everyday life and being able to recognize their use or non-use in a variety of contexts…………and scientific literacy is enhanced when it is accessible to learners. Therefore language development is crucial for both science education and scientific literacy. (NS-24)*

Implicit in this definition is an understanding of some aspects of science content; understanding the scientific approach to inquiry; understanding science as a social enterprise; accessibility to science and communicating science.

Table 5.1 depicts instances of ideological influence in the C2005 policy document

Ideological Dimensions (examples from C2005 policy document)	**Curriculum Emphasis (Roberts (1983)**[2]	**Ideological Influence**
Epistemology and the view of learning		
Learners need to know that science is a human activity, dependent on assumptions which change over time and over different social settings (NS-5)	The self as an explainer	Cross (1997) scientific education ensures that teachers become 'suitably socialized promoters of the the scientific community' (p607) Fallibilistic[3]/ rejection of imperalist position
Learners need to be active participants in the learning process in order to build a meaningful understanding of concepts which they can apply in their daily lives (NS-5)	Everyday Application/ correct explanation	Utilitarian[4]
Processes of investigations encompass a number of different process skills such as questioning, observing, hypothesizing, predicting, the collection, recording, analysis, evaluation and interpretation of data, and the communication of findings and/or conclusions(NS-9)	Structure of Science /scientific skills development	Classical humanistic[5]
Planning and carrying out investigations may be done individually or in groups (NS-9)	Scientific skills development	Collectivism/Individualism[6] Progressivism[7]
Phenomena should be relevant to learners and appropriate to their life experiences (NS-10)	Everyday Application	Utilitarian
......science is not a neutral discipline, but that it is influenced by the culture in which it takes place. Furthermore, science cannot necessarily be seen as the	Structure of science/ self	Different ways of knowing

[2] See Chapter 2 for the different curriculum emphases.
[3] fallibilistic ideology – the absolutist sees the subject matter as unquestionable, objective knowledge, whilst the fallibilist views the subject matter as uncertain and unchanging.
[4] Utilitarian knowledge is intended to prepare students for future employment and satisfying the needs of society.
[5] Classical humanist ideology has roots in pre-industrial society and sees its main purpose of education as preparing an intellectual elite for the task of preserving their society's cultural heritage. The curriculum appropriate to this elite is an academic curriculum.

[6] Collectivism/Individualism- individualism fosters independence, individual achievement, individual thinking and personal choice whilst collectivism fosters interdependence, group success etc.

[7] Progressive Liberalism- progressivism is a political ideal for what is considered good for the progress of society. Child- centred pedagogy is an example of progressive pedagogy. Progressive Liberalism sees the main function of education is to reproduce those forms of social life in which free and equal individuals can determine their own version of a good life and collectively participate in formulating the common good of the society.

only way of making sense of the world around us(NS-19)	as an explainer	
Other cultural means of clarifying the world, such as through language, religion or art, should be seen as having validity and benefit, just as science as (NS-19).	Structure of science/ self as an explainer	Acknowledgement of other knowledge systems Localized science
Access a wide variety of information on different kinds of methods, aims and uses of science in different cultures such as African, Eastern, European…(NS-19)	Scientific skills development	Progressive Liberalism
Science can be seen too easily as a body of immutable truths and therefore as absolute and without change (NS-20)	Structure of science/ self as an explainer	Rejection of absolutist ideology
Axiology **(politics, ethics and aesthetics)** *….awareness that resources are contested and that the view that they are limited…………the social, economic and political factors cannot be ignored(NS-15)*	Science and Technology Decision emphasis	Liberalism/ Utilatarianism
SO8: demonstrate knowledge and understanding of ethical issues, bias and inequities related to the Natural Sciences…..concerns the development of an awareness that science is not value-free and can be misused or abused. On the other hand science can create inequities and show bias, on the other hand science can also help to redress such situations.	Science and Technology Decision emphasis	Discourse ethic of Habermas (1984)[8] Reconstructive Ideology[9]
Metaphysical-ontological **(view of reality)** *The Natural Sciences ……involves the systematic study of the material universe-including natural and human made environments-as a set of related systems (NS-5)*	Structure of science	Formation of an integrated person-liberal ideas about education, overcoming intellectual fragmentation

[8] Habermas (1984) gives four conditions that should be fulfilled in order to resolve an ethical dilemma:

a) All persons which are affected by a problem should participate: dead and unborn persons included.
b) All participants have an equal chance to criticize.
c) All participants have an equal chance to express their points of view, their emotions and intentions.
d) All participants have an equal chance to order, disobey, permit and forbid.

It is not possible to organize an ideal discourse because not all people are available because of temporal and spacial reasons; and participants are no experts in the topic.

[9] Reconstructive ideology stresses that schools should develop students' ability to improve and change society. Treasured values are equality, tolerance and acceptance of diversity. This value system is derived from immense dissatisfaction with the status quo and seeks to challenge it through participation in democratic processes.

The solid foundation[10] is the emphasis that tells students the purpose of learning this year's science is to get ready for next year's, then the next years, and so on through graduate school. This is a 'silent' or implicit emphasis that is typically associated with a science policy documents. The C2005 policy document shows a hybridity of ideologies, underpinned by the broad transformational agenda.

Evidence from policy writers

Policy writer D-C2005 conceives scientific literacy as an understanding of the processes and conceptual knowledge that defines science as a discipline:

> *You know you come to the idea of scientific literacy, the notion of what are the processes of knowledge base, what kind of knowledge is generated and how to do it and what the purpose is. Of course the basic content as well, not to say learn it all. Certainly not more memorization of content. It should serve a purpose in order to understand what science is about. We wanted to develop scientific literacy and we wanted people to talk to it. And tried to distinguish between scientific content and scientific ways of thinking* (Policy Writer D-C2005).

There was a clear shift away from the memorization of content, and an increased emphasis on the discourse of science and being able to communicate science. What is not clear however is how this knowledge is generated and how does one deal with competing knowledge systems. However, Policy writer E -2005 does talk to the issue of alternate ways of knowing and how this could be achieved through Specific outcome six. How does one deal with 'the meeting of cultures' and conflicting worldviews has not been articulated to the depth that it would probably manifest itself in the classroom, given South Africa's multicultural, multi-'worldview' reality.

> *People like ....and I were concerned about the worldview aspect, where you look in learning science you don't necessarily have a scientist worldview. They might come from a background that is far more spiritual or which the supernatural would count for much more in terms of explanations than certain mechanical things from science for e.g. And you have a meeting of cultures here. Science has a culture and of course people in South Africa have cultures and we wanted to sort of bring that up to the surface. Where this comes in distinctly is SO six, it has been watered down a bit to say something like....an understanding of the relationship between science and culture* (Policy writer E-C2005).

[10] The solid foundation emphasis is one of Roberts' (1983) curriculum emphasis (see Chapter 2).

Policy writer A-C2005, comments on science as a social construct, where the conceptual knowledge of science is value-laden and he questions the production of knowledge to be deemed valuable and scientific, i.e., a fallibilistic ideology:

> *Knowledge of science concepts is neither trans-historical nor valueless. It is knowledge that has been developed by all societies over space and time. It therefore has different philosophies and backgrounds but does not necessarily mean it is in conflict with each other, but rather enrich the science knowledge in general. Science attempts to arrive at the truth, but is not itself valueless. Who determines what 'science' is and whose contributions are included should be a matter all learners are exposed to* (Policy writer A-C2005).

Policy writer F-C2005, on the other hand, sees knowledge as valuable if science can be drawn from other cultures and use practically to enrich ones life, i.e., science has established itself as a discipline and science knowledge should be localized both in terms of culture and context:

> *basic concepts about science that have some relevance to their lives and emerge from different tcultures. Applications of these concepts in their own lives, in their communities, in industry, farming, medicine and other aspects of South African lives. Awareness of the use and impact of S&T in their own lives, their community and the South African context* (Policy writer F-C2005).
>
> Policy writer C –C2005 eloquently captures this tension of what should constitute the discipline and provides an example of how one can achieve conceptual change
>
> *This is difficult because one wants, there are some things that are standard fare, and you can't get away from that without endangering people's understanding, at the same time you can get locked into those traditional concepts without exploring the new things that are happening and I had this discussion with someone from the university saying you know with chemistry you need to know all the details, you need to know where on the periodic table and you need to know structure and you need to speculate that kind of things but in physics its so much conceptual understanding that you don't have to work with equations, its just wonderful, beautiful concepts and the regularities with which they work and later on you can get to the maths, it shouldn't drive your understanding, you shouldn't start with 3 X d squared equals etc. You should have a picture in your mind of bigger mass, greater attraction, greater distance and then later the equation takes meaning* (Policy writer C-C2005).

Policy writers' G-C2005 and B-C2005 present science conservatism on two separate issues.

> *You know, the whole idea of the contestability of science may be a problem for me.*

Because Newton's Law and thing like that are not contestable. I understand that yes we have debates and yes you must contest you know the evidence that is given to us or that we teach, I think that's vitally important. But in the sciences you have got to realize that there are some things that are cast in stone. There is no contest anymore. And the whole idea, the whole debate about contestability comes at various levels. I am not sure that children at the age in grade 5, 6, 7 even at grade 9 can have sufficient knowledge to start having rational arguments about the contestability of science. Quite candidly I think these are very difficult things. That they should question things that's vitally important but at what level and depth you question that is another matter. To say that all science is contestable I think is a very dangerous statement (Policy writer G-C2005).

This is an indication that although the specific outcomes may have been an outcome of negotiation and consensus (a 'policy settlement'), some policy writers in their own minds were not as convinced of the issue and propagate an 'absolutist' ideology. Policy writer B-C2005, comments on the issue of redress and the apparent difficulty of achieving this if science is accessible to all:

I think that many of us felt that science could only redress past injustices and poor levels of education where it would have been virtually made an injury through the apartheid system. Science could only redress that by offering good science, offering itself to those errs, what I mean is by making science accessible to those people. I think there was enough science conservatism on that LAC to say don't go in there with something that is a) accessible and b) science because by making it totally accessible you probably would not be doing science. We believe that there was enough in science to remain science and still be accessible at whatever level. As I said there was enough science conservatism over there to believe that it was not acceptable to have something that was not science be-labeling as science in the name of redress. Because the only way you redress a lack of science education is making science education accessible and not by worrying more about the accessibility regardless of what is actually on offer. Therein was something of the debate because I think the people rather irresponsibly from the science education point of view were more worried about the redress issue and were saying science content be damned (Policy writer B-C2005).

This signals the discipline of science as a particular body of 'truth', science as a discipline has clearly established boundaries and clearly defined parameters for the selection of conceptual knowledge. Policy writer B-C2005, clearly sees the triumph of conservatism dominating what the outcome of the C2005 process was in terms of the conceptual knowledge:

I think to some extent we didn't allow the political redress issue to dominate within the science group and I think part of that came out because we got our themes, these themes are central to science education. Use it for redress by all means, nobody is arguing against that, but use science, don't use something you call science simply for the process of doing what you think is redress because in the end you will only redress by teaching decent science, by getting science literate people in this society. You don't get science literate people by producing some kind of thing that don't prove anything but is given the name science. A curriculum whose scientific thought and hypothesizing/modeling is carried out with the minimum of mathematical obfuscation i.e., where the science is not subjugated to mathematics too early in order to give it (artificial) respectability; where the subject matter is wide ranging, open to choice by teachers and learners and where subject matter is selected on the basis of science concept and skills (process) development before content for content's sake (Policy writer B-C2005).

On issues of axiology, policy writer F speaks about ethic issues and responsibility, but not how these ethical conflicts could be resolved (Habermas, 1984 discourse on ethics):

> *Valuing of science as a way of meeting societal needs but possessing a critical attitude towards use of S&T in society; enjoyment of science; respect for the knowledge and beliefs of people from a variety of different contexts; responsible attitudes towards their health and the health of others and towards the environment* (Policy writer F-C2005).

Policy writer C-C2005 captures the issue holistically and relates ethics to language, relations and having adequate conceptual knowledge, i.e., to make intellectually informed decisions:

> *....ethics, skills on three levels: how you think differently, how you act, creativity with language or visual/performed art, putting information and seeing new relations. Essentially doing science but not mechanically understanding why things are the way they are, how you control them, what are the relations. Does the values relate to knowing enough about science? How does it inform your decisions in relation to other people?* (Policy writer C-C2005).

On ontological dimensions of scientific literacy, Policy maker B-C2005 has strong views on the meta-physical as 'truth' and the challenge of 'authority'. There is a clear focus on rationalism:

> *Appreciation of the delicacy and intricacy of life in the immediate environment; of the fact that our senses and curiosity taken to systematic enquiry can be a primary source of new knowledge; that problems can be solved through systematic investigations and by following inspired guesses are based on focus rationality and are not mystical entities; that my intellect is good enough to discover things that are new and interesting to me and that I have the capacity for insights that may disagree with 'authority'* (Policy writer B-C2005).

(c) Selecting Conceptual Knowledge

The C2005 policy document in the rationale, raises the 'content-free' idea....

> *Learning Programme developers should take cognizance of the need to reduce content so that time will rather be used to develop the Specific Outcomes and their implied competences, attitudes and values (NS-4).*

This under-specification of content is reflected throughout the document. Although the scope statement indicated the scope of the content area, much was left to classroom teachers to select content that enabled one to achieve the specific outcomes. The scope statement also suggest that ' *learners must understand at an appropriate level'* progression from one grade to another was not specified and it was left to the classroom teachers to determine this 'appropriate level. Content is presented at the end of the column on range statements and ended with ....indicating that the list of content topics were not exhaustive. Under-specification of content was not based on pragmatic reasons, but pressure from the department in order to move away from a content-laden syllabus. The approach adopted relied heavily on the ability of the teacher to select context using the scope statement speaking strongly to the concept of devolution of curriculum. There was no limit to the amount of content. The results were that teachers chose minimally (Taylor and Vinjevold, 1999). A content analysis of the C2005 Natural Science policy document according to the specific outcomes and the main content areas is presented in appendix (B). The 'experts' in the choice of content were the three policy makers of the technical committee. The broad LAC did make suggestions on content, but the final selection was made by the technical theme. The community of scientists/science educators made inputs at the LAC level. The four main content area that were chosen by policy makers of the technical team were: planet earth and beyond, life and living, matter and materials, and energy and change. There did not appear to be a strong push from the academics to bring in certain kinds of content at the GET phase as is reflected by Policy writer D:

Traditionally when you talk about a curriculum for schools the professors will say well what do we want the learners to know when they come to us. That might have been that kind of thinking certainly when we talk about grade 1 to 9 scientific literacy its not about preparing for first year physics. We did take into account the needs of the learner

and of the society, we narrowly perceived as academics we are interested in getting students at the university which says nothing about what that student should be learning and what their concerns should be and certainly we didn't do that, but on the other hand yes we were many from the academics were involved in designing it and you mustn't go with the idea that their interests were to bring in certain content (Policy writer D-C2005).

and

I know there has been a pressure group in the Western Cape, pure science – tried to create a very academic curriculum but in Gauteng we strongly propose the real/big ideas because we believe in the science for all-I think that people around the country are much more aware of the debates around science education- I would say that even though at national workshops I was involved in, there were tertiary people who put a pusher on academic agenda and I don't think they succeeded and there were tertiary people that opposed the academic agenda so I wouldn't say that they influenced the new curriculum in any way. That was my impression- I must say I was only deeply involved in the 1996 conferences leading to the specific outcomes workshop (Policy writer F-C2005).

There was a tendency that one had to move beyond the traditional conception of science as physics, chemistry, biology to create a local pool of the country's engineers:

One of the big influence came from someone at Wits- ....who pushed for earth sciences and he brought the whole geological science society behind him and really pushing for sciences in the natural sciences because of the need-the shortage of earth scientists/ shortage of engineers in the earth sciences area and the need for more people coming out of our communities rather than being imported from overseas- just a realization that elsewhere in the world earth sciences was very much part of science that wasn't a social science- so that to me was a very important influence and a valuable influence it wasn't scientific or an academic curriculum –obviously there was a notion that there was a need for more people in this field of study but it wasn't an attempt to influence the content of earth sciences-but just to push that as one of the strands in the natural sciences. (Policy writer F-C2005).

There was sufficient conservatism in the group not to 'dilute' science, as mentioned earlier, clearly an influence of international conception of science but also a protest against how the 'content free idea' could be fundamentally flawed:

.......but the concern that came through there and which I think eventually won the day was if you are going to call somebody educated in science, there are certain things you cannot avoid doing and teaching, there was a definite sense that the science

not be diluted simply for what looked like grand political ends. Here is the science in order to achieve the critical outcomes. If you're going to take the critical outcome like understanding the relationship between science and technology and science and society, you could only do that with a base of a certain amount of content knowledge, and more important concept knowledge of science, which is where the idea of the themes and the sub-themes were borne, especially the themes which contained key concept areas like energy, the nature of life, the biotic factors, what goes on. We couldn't do without those things and we fought very hard for that (Policy writer B-C2005).

and

Specific content for the Natural Science was not well-enough spelt out in the first version of C2005 and such content as was put in had the status of 'suggestions' for lesson activities. One obvious problem with the first version of C2005 was the discourse that developed around the 'disappearance' of content. Content had not disappeared, but certainly appeared to have taken a back seat. This perception was not correct, but was certainly not explicitly argued against in the policy documents. So the whole issue of 'content' as such had become a bone of contention and the policy document did not address this adequately. Content definitely was under-emphasised, under-developed and masked by many unnecessary technical design details (phase organizers, performance indicators, learning area organizers etc) (Policy writer E-C2005).

The interesting thing here is that no-one in these interviews was really questioning the basis in Physics, Chemistry and Biology: the changes in content that they anticipate are Earth Science, applications of science, fuller discussions of the nature of science and some [undefined] notion of African science. Policy writer E-C2005 makes oblique mentions of vocational education, also undefined. Beyond that, their concerns were largely about purposes, and pedagogy: context-based learning, problem-based learning, constructivism… In other words, their 'updating' was more about purposes (broad social purposes, detailed learning purposes) and curriculum design than curriculum content (perhaps this is fair enough – lots of different content can be used to suit any chosen purpose, and perhaps, at school level, changes in the social understanding of science are more important than changes in the detailed content. Curriculum is shaped by current understandings of the nature and needs of science; the nature and needs of children and; the nature and needs of society. These natures and needs have all shifted significantly. The question to be asked is how that might or might not shift the content.

The writing team was free to choose content – while they might have anticipated pressures from environmentalists, feminists, Africanists, industrialists, academics, there were no organized lobbies, meetings, or submissions. At the same time, there were LAC meetings, and public discussions. It is not clear how aware the writers were of the 'big picture' discussions between unions, employers, government etc in framing the NQF – and the curriculum discourses of the time. However there were pressures from the Department not to specify content, but policy makers felt otherwise and strongly contested this. Drawing from their combined experience of many years of field work, pragmatism and international trends dictated that outcomes could only be achieved through a body of content. There was also a view that certain content in science was cast in stone and cannot be left out of the policy documents. This body of knowledge could not be contested. The strong feelings of policy writers bring the issue home:

> *Eh, we need to distinguish between the four broad themes and the content. There was a general agreement that earth science should become part of the natural science curriculum because internationally that's common and for the rest we were influenced by the Australian Curriculum documents, which is a well worthwhile one, called science profiles. It has a very broad sweep, it takes in a great deal and so we were influenced by that and again you'll see the similarities of the titles of the four themes there. As regards content we never got to that. As you probably know there was from the side of National Education, people like…………, there was a strong antipicy to the lecturing of the syllabus and the pendulum swung far the other way until the very word content would raise tensions immediately, like the notion that children should proceed through a series of ideas which were actually laid out over the years and build up a framework of important ideas in science. Everything must be done in terms of outcomes. In fact when writing activities you should actually look around for context because that represents content. You could only do that at the end. Talk about a content free curriculum. Nobody was allowed to put in any content (*Policy writer E-C2005).
>
> **and**
>
> *To me, I kept on saying there are certain concepts that have to be included because you have to teach that content and you can't say we will choose an outcome and see what content will perform that outcome. You are going to finish up with a disjointed programme, we are going to miss a lot of vital knowledge. This whole process was driven by educationists and non scientists who didn't understand the need for a certain body of content. You cannot teach science without a certain body of basic knowledge, understanding of it, fundamental concepts. The other problem was in designing the outcomes the original outcomes, all twelve of it or whatever the number was, a lot of those were not appropriate in many cases to physical sciences, or physics and astronomy, it isn't there. You know, the whole idea of the contestability of science may*

be a problem for me. Because Newton's Law and thing like that are not contestable. (Policy writer G-C2005).

There was contest at the level of ideology particularly SO 7 (*demonstrate an understanding of the changing and contested nature of knowledge in the Natural Science*) as mentioned earlier. The feeling amongst some policy writers was that scientifically and internationally, certain knowledge in science is not contestable, to claim such in a SO belies the nature of the discipline. Also, there is a strong emphasis on localization of conceptual knowledge. However what is not clear is the place for new knowledge and how these can be developed in classroom contexts- SO 8: *'science cannot necessarily be seen as the only way of making sense of the world around us'*:

Difference in content is more of a contextual issue than a 'knowledge' issue. All core concepts etc as mentioned before should be learned by all South African learners. The context and examples used can be different. Some more emphasis on certain issues based on geographical location could also occur (industry in Gauteng, agricultural development, tourism, bio-diversity) in Limpopo. But it does not mean that certain topics/concepts will be dealt with only by certain (geo-graphical) groups, everyone will deal with all topics, the emphasis/weight might differ to a limited extent (Policy writer D-C2005).

and

A difficult issues since learners can be disadvantaged both ways. Perhaps the same curriculum and content but with examples/applications applying to local situations. E.g., if an issue-based approach were used, one could contextualise the investigation e.g., causes of pollution in a river- In rural areas learners could investigate leakages from pit toilets, effect of pesticides and fertilizers, timber factories upstream etc. In an urban area, the problems may be leakages from gold mines, industrial effluent, litter etc. Different examples, similar knowledge, skills and values being developed (Policy writer E-C2005).

Policy writers agree those certain concepts and content areas key to defining science and those concept areas can be developed using both local and global contexts. There is an agreement that the local and familiar are used as vehicles for teaching and learning but that science is grounded in a core body of knowledge/concept that every learner should know. This view is re-iterated by policy writers, each providing unique examples of how his could be achieved:

You need both. You have the same curriculum without specifying the detail of the content but the concept e.g., gravity and the understanding of gravity is important, that's in the curriculum, now how you teach it and how you interpret it and how you get that understanding must be local (Policy writer C-C2005).

There is some content and there are some concepts without which no-one can be said to be science- educated. From this point of view the curriculum should be the 'same'. (Again this becomes a non-question unless one confuses 'curriculum' with 'syllabuses'). Most of the concept areas that must be covered can be developed by using the local and familiar as vehicles for this learning. Local is lekker but this does not have to become doctrine either. Education is also about expanding horizons. As long as one begins from a place that is familiar to learners it should be a requirement to go beyond the local and expose learners to wider possibilities (Policy writer B-C2005).

This all became contradictory later as policy writer B-C2005 presents his view of the exciting way in which science conceptual knowledge is presented as a 'hotch-potch' of politically and internationally correct trends:

> *A little bit of geology got into the syllabus (but too little); a little bit of biochemistry got into the syllabus. Some more attention to Indigenous Knowledge Systems got in also. Moreover, for a social constructivist approach (which is largely the approach taken in the Natural Sciences document) to have a serious chance, learners must develop an awareness of the nature of (scientific) knowledge, and therefore have some inkling of history and philosophy of science. This also enables a debate on science and culture and further enhance the development of 'ownership' of knowledge and understanding that the learners develop* (Policy writer B-C2005).

Policy makers struggled with defining an Africanised science curriculum, compounded once again by time pressures and conservatism in the group:

Well we never got to a stage where there could be a struggle over that. The most it came to was the O Monde meeting in Sept 97 and you can get the summary from……. where you can pick up the range of ideas. There was certainly a feeling that this should be a South African curriculum and redress was seen as important but in a two day get together of about thirty people there was never enough time for issues to become clarified. So people were for the idea of a South African curriculum, quite what that would mean or what it would not mean that was never debated or articulated. People like….. and I were concerned about the worldview aspect where you look in learning science you don't necessarily have a scientist worldview. Then there were other people who were saying that the environment is what counts, lets have a theme on environment. And other people would say if kids cannot understand the difference between melting and dissolving then we were not going to get very far. There was a big debate about that but there wasn't time for it (Policy writer E-C2005).

As a policy statement, the preamble to the C2005 policy document makes explicit that the Natural Science Learning Area is committed to: '*challenging the perception that Science is predominantly a European discipline*'(NS-2). There is reference to alternate forms of knowing: '*....science cannot necessarily be seen as the only way of making sense of the world around us. Other cultural means of clarifying the world, such as through language, religion or art, should be seen as a validity and benefit, just as science has*'NS-19). The reference is two fold in the sense of the *'uses of science in different cultures'* and '*ways of describing and explaining phenomena*' (NS-19). The document acknowledges others ways of knowing but the methods of exploring this and dealing with conflicting knowledge systems is left to supporting documents and classroom teachers. In Appendix B, limited examples of the conceptual knowledge supporting this statement is presented (see SO6). Policy writer D speaks of the groups conservatism and how constructivism in teaching could bring to the fore different knowledge systems but excludes issues of conflict, power and dominance in varying knowledge systems:

We had debates, they were constructed debates about traditional medicines, talk about songomas if we talk about indigenous knowledge systems etc, etc, etc......not everyone found it easy to accept you know those kinds of things to be included in the science curriculum, against any other curriculum. We argued about it and I know people got to realize maybe you got a point, and we should include that kind of thing, there were that kind of debates and also when we developed the set of outcomes, the nine specific outcomes, the outcomes I formulated myself on the contested nature of science and the relationship between science and culture and those issues because I found not only from a political if you want to call it that point of view but also from an educational point of view it works from essentially a constructivist paradigm you view knowledge is socially constructed and if you are involved in constructing it what kind and what language and what content and does it allow people to take more ownership of science knowledge. I think they might see that the knowledge that they have their place, technology and traditional knowledge and where the science knowledge is being presented. It's not really being nice to the African context. It will allow them to develop more ownership of the knowledge they are building up over the years in schools (Policy writer D-C2005).

5.2.3 Summary

Pre-C2005, science in South Africa was highly concept based and abstract. There were no initiatives to define the nature of science; address issues of lack of meaning in the curriculum; instrumental view of learning; narrowly defined skills; reductionist notion of science knowledge; an acknowledgement of values only in the aims of policy documents; a skewed education system and; intellectual fragmentation of the system as a whole. The C2005 reform process brought about (albeit at the symbolic level) broad shifts in the nature of knowledge and the notion of scientific literacy. Scientific literacy defined through the Specific Outcomes offers a broad conception of the nature of science; the positional nature of science: science knowledge is contested (SO7), i.e., a rejection of the imperalist position of knowledge; the value-ladeness of science (a challenge to the European conception of science); an acknowledgement of other knowledge systems and ways of knowing (SO8) and; a constructivist notion of learning (SO2). The definition of scientific literacy gleaned from the document comprises five aspects: conceptual knowledge, a scientific approach to inquiry, science as a social enterprise, accessibility to science and, communicating science. There is also a strong emphasis on localized science; liberal ideas about education in order to overcome intellectual fragmentation (study of the universe as a set of related systems, integrated knowledge); thematic approach to concepts; a learner centered pedagogy and; a focus on the social dimensions of science (broaden access, address redress and past imbalances).

There were complexities in the accounts of policy in that policy writers were less clear on the selection of conceptual knowledge. No one in the interviews questioned the basis for Physics, Chemistry and Biology. There were no major shifts from the broad conception of the discipline internationally. There was a clear emphasis on other ways of knowing (SO8), but the notion of African science was undefined. Also undefined was the notion of vocational education and what it would mean in the science curriculum. There were elements of science conservatism (*not to dilute science for the sake of redress*) which is at odds with the contested nature of science (SO7) - an indication of some 'policy settlement'. There is a renewed focus on the ethical dimension of science (axiological) but little discussion on the ethics discourse (Habermas, 1984). Science is also seen as an individual or collective activity but it is not clear whether scientific literacy as an individual or a collective phenomena. A strong individualized notion can be inferred from the policy document.

5.3 How did C2005 play out in practice? Three years experience, Research and the Chisholm Review

As many critics had warned, C2005 soon ran into a myriad of difficulties that threatened the survival of the new curriculum (Tema, 1997). At the beginning of 2000, when it became clear that the implementation of C2005 was not going well, the new Minister of Education, Professor Kader Asmal, ordered a review of the C2005. He was very clear that **the principles underpinning OBE are not the subject of scrutiny.** After a short 3-month process of reviewing various submissions and documents, and performing site visits and interviews with key role-players, the Chisholm Committee published its findings. It found that the implementation of C2005 was compromised by the complex structure (coherence and details were not clear) and design of the curriculum, tight time frames, lack of resources, a weak model of teacher training, insufficient learning support materials and poor departmental support to teachers (Chisholm, 2000:27). The review team recommended that the Curriculum 2005 be streamlined, phased out and 'strengthened' with a revised version in the form of a National Curriculum Statement. The proposed streamlining and discarding some of the problematic designs of C2005 like range statements, performance indicators and phase organizers. The review committee did interview the chair of the Natural Science Committee but the nature of the interview was broadly about C2005 rather than specifically about science.

The criticism that we had from people about C2005 that I have, but what her said, I mean that's a very long time I can't remember but I do remember him saying that the science group of C2005 was better than others and that science was not an open-ended list that others had gone and that's how I remember it now I mean its very vague to me. I do know that people said the science was better done from the other learning areas. Science was better designed. The science did seem to have organizing themes. That was a perfect match. That was certainly one of the things we strongly criticized. I think that what he said during the interview was to the defend the criticisms in science curriculum in relation to C2005 because the science curriculum was better written than the others, I remember that part and I think he tried to defend the fact that we should move too far away from what is there, but to stay close to what is there (Review Committee Representative: on interview conducted with Policy writer B- C2005).

The important point is the requirement of streamlining, which meant reducing the number of outcomes, and introducing standards. This shifted the structure of the documents to be more like overseas versions such as Australia's. Further the collapsing of SOs to three (knowledge, skills, social contexts) made the set of outcomes less radical than in C2005. The specification of content was remarkably traditional in the NCS (in July 2001) and gave way quickly to the revised NCS (Decemeber 2001). There was clearly a qualitative shift from the NCS perspective to the RNCS perspective. What happened in the environment that led to this shift? Hence the focus on the RNCS…

Section 2

In this section I document the issues that have shaped policy choices and how the outcome of these choices is reflected in the policy document for the RNCS. The section is organized broadly into two parts: part one documenting the issues and troubles at the time and part two with how these are reflected in the notion of scientific literacy. I conclude this section by drawing out the key influences on the notion of scientific literacy and how this compares with that of the C2005 process.

5.4 The Revised National Curriculum Statement (RNCS) process:

5.4.1 What were the public issues and private troubles for the Science Writing Team now?

The aim of the RNCS is stated as being to 'build on the visions and values of C2005' to promote 'democratic values' and to prioritize 'justice and social citizenship'. The key change features evident in the *Draft Revised National Curriculum* (2001: 1- 40). In addition, each province or school will be expected to formulate their own contextualised Learning Programmes from the NCS (the 70/30% rule gave schools room to contextualise, not only teaching, but the choice of content). The formal integration of science and technology in the foundation and intermediate phase is also important – their outcomes and standards at these levels are compatible. The terminology and language of communicating the ideals of the RNCS is much simpler. There appears to be a much better balance between integration and progression. In each grade, the Assessment

Standards details progressively more complex and deeper knowledge and skills. This resembles Brunner's concept of a 'spiral curriculum'. For the Natural Science writing team in the RNCS there was no change to the basic position. In fact the writing teams position on Natural Science was strengthened by staying with the four big ideas in defining conceptual knowledge, paying attention to progression, making integration more explicit, defining standards and assessment levels similar to the Australian document except for subverting the structure. The brief to the team was 'high skills, high knowledge'. Policy writers articulate why they saw it necessary to shift broadly from the C2005 position. Policy writer A – on the RNCS speaks of the public pressure to have the curriculum reformed:

The review was necessitated by the overwhelming support from the public for a simpler, not overloaded, overcrowded and over-designed curriculum. So the new leadership comes in, there's pressure on the ground, they say look but the Review report says there's under-specification. There's pressure on the ground for more specification (Policy writer A- on the RNCS).

And

Generally the level of understanding of the principles of C2005 varied to a great extent. There was lack of clarity in policy documents, confusion with regards to concepts and implementation. The language and terminology was too confusing with regards to its structure and design. There was curriculum overload, thus resulting in insufficient time for the development of science concepts. The design structure was too strong on integration but weak on conceptual development, lack of guidance with respect to content (Policy writer H-RNCS).

The call for more specification can be seen in two ways: clarity of the document's purposes and possibly ways to localize definitions of scientific literacy, or more detailed guidance for implementation (i.e., closer control from the top, and shifting responsibilities for curriculum design upwards from teachers). Policy writer E- on the RNCS relates how the implementation process for C2005 evolved in Gauteng, concerted efforts were marred by tensions between the department officials and the curriculum development teams:

I can't speak for anything except Gauteng really. Science has been suffering from very low standards as well, becoming the norm and that was acceptable. I think the major effort, possibly the only coherent effort for curriculum development was at the GICD, and teams of people were put together to develop materials for C2005 and in that writing the tensions between the practioners and the people who were writing materials and who had contact with the schools, they on the one hand and the DOE officials became very apparent. People that were writing and saying what they have is what children can do, that is what you had to keep in mind in the activities while the DOE officials were extremely focused on pushing all curriculum development through the mesh of choose phase organizers, choose SOs, choose assessment criteria, find out performance indicators, do all those kind of planning. People who were actually working on this said you know this is nonsense, people don't think of these in their teaching. They should be thinking of the children and responding to the children. So there were moments of high tension and a complete breakdown at points between the curriculum development teams and the bureaucrats in the department who were fairly obsessed to see policy carried through that way (Policy writer E- on the RNCS).

It is perhaps important to acknowledge here, that policy writers with their individual histories and coming from a range of organizations like the Sethlare Trust, GICD, SYSTEMS etc were writing support curriculum documents, playing around with assessment methods, working with teachers, etc. Key policy writers knew the overseas documents, especially the Australian documents well – they had been a point of reference for C2005 and they had been greatly important in the Gauteng[11] Institute of Curriculum Development (GICD) project. Policy writers cite reasons mainly related to implementation issues and recommendations from the Review Committee as the reasons why the curriculum needs to be reformed. Once again reform took place broadly rather than specifically in a learning area. Policy writer A- on the RNCS and Policy writer E- on the RNCS speak of the public pressure to have the curriculum reformed:

All learning areas in C2005 were reviewed, including the Natural Sciences Learning Area. The review was necessitated by the overwhelming support from the public for a simpler, not overloaded, overcrowded and over-designed curriculum. That you must understand it within the historical and political climate(Policy writer A- on the RNCS)
and
The review report reflected the concerns and pressures of people that were alarmed at what was happening. Schools were not able to cope with C2005, this came out of a report from JET. It came out of the Chisholm review committee report. I think the Review process report that was published on the 31 May 2000, the fact that it happened

[11] Gauteng is one of the nine provinces of South Africa.

at all, the fact that the Review Committee was appointed, they were appointed towards the end of 1999 which left them two years into the implementation programme, that in itself tells you there was a lot of pressure, coming from people that were alarmed at what was happening. So the report that came out was obviously a compromise document as these things always are. But I think it reflected those concerns. There were evaluations being done of the training programme and what was happening in the schools. I think one of the major influence was the JETS report: Getting Learning Right, by Nick Taylor and Penny Vinjevold, a report by the President's Education Initiative research project and it was published by JET itself and they were basically saying that schools were not able to cope and from JET there was quite a strong feeling that C2005 had lost touch with reality and there were comments like this was a complete waste of time, what was needed was a simpler, clearer syllabus, more of teacher training and better monitoring of schools. It said that teachers were not teaching and that low standards were becoming acceptable. So, yes that fed into the Review process and those were the major pressures (Policy writer E- on the RNCS).

After the first draft NCS went out for public input in July 2001 four advisors were added to the science group. Advisors cite reasons mainly related to the first draft of the NCS that went out for public input. Policy writer J-RNCS speaks specifically about the first draft being too content based by the four themes and the need to write outcomes for the foundation phase. Policy writer K reflects on the political pressure to address the public input:

It was about the outcry and something that I must say Kader Asmal[12] *said the following, these inputs must be addressed because the last thing we want to see if any one writes in and says they didn't do anything on it. So because of the heavy critiques there was need to review and I think science had the most, they shifted the critique to nice to know and that we must take note of. It wasn't done by us, it was done by department. I don't know who, they gave it to someone who had done that* (Policy writer K- RNCS).

Policy writer L-RNCS and Policy writer M-RNCS link the reform efforts to implementation, the need for the policy document to be more user-friendly in terms of implementation and the shortage of time, orientation, teacher development. Policy writer J- RNCS captures an experience that was critical in the writing process and in examining what had gone in the draft stage of the document:

[12] Professor Kader Asmal was the second minister of education since South Africa's first democratic elections.

The feeling was I think even for the intermediate phase where there is quite a lot of content prescribed by virtue of the outcomes and the assessment standards and whatever, the feeling was you didn't want kids to learn a lot of stuff about little over and over again. And that you really want them to understand the nature of inquiry and investigation that underpins the whole science curriculum. That was a very big shift. To outcome number one where there was the investigation, I think that was a huge shift and I think that actually started from the bottom up. What had happened, sorry I may be rambling but I think what had happened initially the curriculum, the science group in the first draft worked backwards from what they wanted to see in grade nine, and that was when we landed with a very strange looking assortment of content. And when I came on board I said you sort of got the donkey by the tail, lets turn it by the head to look at were do you want to start. What's the best starting point for content was really grade 4 and we had agreed on it that we didn't want to put content for the foundation phase. What was actually most we want a grade 4 child to be able to do so that now you can build your science curriculum from grade four upwards (Policy writer J-RNCS).

The impetus for reform in both the periods were clearly different. Whereas C2005 was responding to transformation of the whole education system where there were both educational and political necessity to do so, the NCS was responding to the implementation and evaluation of C2005. It was clear that there was no attempt to re-design the curriculum, rather a streamlining and strengthening process. The final version of the NCS was in response to the draft statements released for public input. The reform process was not just about reforming 'content' – it was about unifying curriculum into a single 'national curriculum' (hence breaking the racist/geographic basis of the old syllabi) and at the same time promoting localization and breaking down 'privilege'. The solution was a national framework of outcomes (as broad competencies) and principles of learner-centredness, outcomes based and integration of knowledge but with devolution of curriculum design and the writing of learning programmes. The need for change and the idea of central framework with a devolution of curriculum design at the school level.

5.4.2 Ideological traces in the notion of scientific literacy for the RNCS process

(a) Purposes

The RNCS policy document in its purpose makes specific reference to **scientific literacy** (Unlike the C2005 document it does not offer a definition of scientific literacy but does state how scientific literacy can be promoted):

> *The Natural Science Learning Area deals with the promotion of scientific literacy. It does this by: the development and use of science process skills in a variety of settings; the development and application of scientific knowledge and understanding; and appreciation of the relationships and responsibilities between science, society and the environment (RNCS-4).*[13]

This definition, as appropriate, is simply a statement of the three outcomes. The nine specific outcomes of the C2005 document is reduced to three learning outcomes. In doing so, links to the specific outcomes of C2005 were removed. Also the nuances of the specific outcome could not fully be expressed in the new statement of learning outcomes for e.g., SO5 (*use scientific knowledge and skills to support responsible decision making)* could be achieved in LO3: Science, Society and Environment under the heading of '*the scientific and technological choices people make reflect their values'* but does not speak to the issue of responsibility and assumes that a value position is responsible and accountable. In a comment made by policy writer N-RNCS, places the burden of this development on the shoulders of classroom teachers:

> *Not this curriculum but the draft one in particular, that too much priority was given to social transformation, social justice issues and too little to science. I suspect that has come through because some people have a narrow interpretation of what science is. Because if you look at our learning outcomes one and two, these to a large extent define science in the traditional sense of the word but of course we are saying that the way its going to be taught is going to be different. Learning outcome three really focuses on social justice issues so we are saying that was the challenge for us, of transforming society on the one hand and making sure that we actually teach science in such a way that everyone is scientifically literate and saying at the same time, not staying at the level of literacy but allow opportunities for those who want to continue with science to have at least a sound scientific background. But at the same time allow opportunities for those who don't want to continue in science but still want to become environmental minister. We think we have achieved that balance* (Policy writer N- RNCS).

[13] The RNCS-4 refers to page 4 of the Natural Science policy document (DOE, 2002)

The document elaborates on each of these goals forwarding both scientific and cultural imperatives for the development of scientific literacy.

- **Development of science process skills**

The teaching and learning of science involves the development of a range of process skills that may be used in everyday life, in the community and in the workplace. Learners can gain these skills in an environment that supports creativity, responsibility and growing confidence. Learners develop the ability to think objectively and use a variety of forms of reasoning while they use process skills to investigate, reflect, analyse, synthesise, and communicate (NCS-p4).

- **Development of scientific knowledge and understanding**

Scientific knowledge and understanding is a cultural heritage that can be used to: answer questions about the nature of the physical world; prepare learners ***for economic activity*** *and self expression; lay the basis for further studies in science; and prepare learners for active participation in a democratic society that values human rights and promotes environmental responsibility (NCS-p4).*

- **Science and society**

Science and technology have made a major impact, both positive and negative, on our world. Careful selection of scientific content, and use of a variety of ways of teaching and learning science, should promote understanding of: science as a human activity; the history of science; the relationship between Natural Science and other learning areas; the contribution of science to social justice and societal development; responsibility to ourselves, society and the environment; and the consequences of decisions that involve ethical issues (NCS-p5).

The RNCS document also recorded a shift in the position of conceptual knowledge from a conceptual free curriculum to a high skills, high knowledge framework. This meant that conceptual knowledge had to be specified. The science team interpreted this as a detailed specification of conceptual knowledge in a separate chapter titled *'Core Knowledge and Concepts'* (see *(c) of this chapter on conceptual selection).* The policy document also explicitly emphasizes the goal of **'science for all'**:

> *....it starts from the premise that all learners should have access to a meaningful science education, and that arbitrary selection and rejection based on various kinds of biases should be avoided........the Natural Science Learning Area must be able to provide a foundation on which learners can build throughout life* (NS-p5).

In addition to providing access to science the emphasis also falls on providing 'meaningful science', access loses its impact if it is not meaningful to the majority of learners for whom this curriculum is designed. This is an articulation of Roberts (1983) solid foundation emphasis. This view is echoed by policy makers, especially as a goal for the GET phase:

> *There is no debate at all. In the Foundation, Intermediate and Senior Phases it must be "science for all". Anything else will continue to deny the majority access to science at higher levels and this has tremendous significance (including economic significance)* (Policy writer N-RNCS).
>
> **and**
>
> *One needs to recognize that the people of South Africa operate with culturally influenced perspectives. Hence all learners should have access to a meaningful science education. Arbitrary selection and rejection based on various kinds of biases such as elitism must be avoided. Meaningful science education must be learning- centered in order to help learners understand not only scientific knowledge and how it is produced, but also contextual and global issues that are embodied within the Natural Science* (Policy writer H- RNCS).

Policy writer O- RNCS and policy writer J- RNCS concur that in the GET phase there should be the development of 'science for all', with specialization occurring later. Not unlike the policy writers of the C2005 process, policy writer A- on the RNCS sees the tension as a perceived tension and links the notions of 'science for all' and 'science for elite' to broader notions of 'individualism and collectivism'.

> *The perceived tension is a social construction. It exists in a society that promotes individualism at the expense of collectivism. Assessing science in such a society does not accommodate exchange of socialization. Sharing is a swear word as it is tantamount to copying. The new outcomes-based approach promotes co-operative approach to learning. If implemented well, it will bridge the historical gaps (racial, gender, rich/poor, etc)* (Policy writer A – on the RNCS)

Also linked to societal effects, Policy writer L- RNCS concurs with the goal of 'science for all' developing in the GET phase, but links science for all with broader social purposes and limitations and the power of science as a way of knowing. Inferences are made to the boundaries of science and acknowledgement of other ways of knowing:

> *The impact of science and technology affects everybody. At this level all should appreciate the power (and limitation) of this 'way of knowing'* (Policy writer L- RNCS).

Other goals that are made explicit in the document are that of science for economic and personal development. Policy writers do not see a tension between these two goals but regard the development of both as significant. Policy writers H and L- RNCS links these goals with that of scientific literacy.

I do not see these as mutually exclusive. Individuals who are scientifically literate are in a better position to contribute to economic development while also leading significant lives (Policy writer L- RNCS).

In the current climate science for economic development seems to be the focus of science education. This perception leads towards negativism-due to the lack of emphasis on human rights issues. With the inclusion of social justice, human rights and environmental issues in the Natural Science NCS it is hoped that the above situation will change. A scientific literate citizenry will also ensure that science foe economic development and social development will be pursued (Policy writer H- RNCS)

Linked to the discussion on collectivism, Policy writer A- on the NCS regards this distinction as artificial, especially in African cultures.

In an African culture, artifical distinction between the social and the economic or between the economic and personal is non-existent. Such an articifial distinction was imposed through a systematic socialization of "separate education". The new science curriculum is underpinned, among others, by the principle of Human Rights and Inclusivity. These principles ensures that the science curriculum is inclusive and contributes to nation building. A nation that is defined by the constitution to be non-racial, non-sexist, multi-faith, multi-lingual, free, responsible, equitable, at peace with itself and promotes unity in diversity. Such a science will, in polity terms, be able to reconcile the perceived social/personal and economic tensions. In practice, those involved in the implementation of such a science must be equipped with knowledge and skills to develop learning programmes that will contest to such a policy (Policy writer A- on the RNCS).

This comment is ideologically loaded, and underpinned by the broad transformational discourses that regulated the development of the post apartheid curriculum. It identifies strongly with the transformation agenda and a social reconstructive ideology especially with regards to righting the 'ills' of the past for e.g., sexism, racism etc. Policy writer K- RNCS brings to the discussion a holistic perspective of achieving these three goals through the specific, developmental and critical outcomes:

Huge problems, huge educational debates around this. But looking at the critical outcomes, one of the critical outcomes speaks about development for vocation. The seven critical outcomes are all about personal and social development. If you look at developmental outcomes there is one or two that lead to that. So I think we have a healthy balance of both worlds, but if you look at the critical outcomes there is a greater emphasis on personal and social development (Policy writer K-RNCS).

(b) Notions of Scientific Literacy

The RNCS policy document

The RNCS policy document in its purpose makes specific reference to **scientific literacy** (Unlike the C2005 document it does not offer a definition of scientific literacy but does state how scientific literacy can be promoted):

Table 5.2 depicts instances of ideological influence in the RNCS policy document

Ideological Dimensions (examples from RNCS policy document)	**Curriculum Emphasis (Roberts (1983)**	**Ideological Influence**
Epistemology and the view of learning		
...science has roots in African, Arabic, Asian, American and European cultures (RNCS-p4)	Structure of science	Cobern(1996) Ideologies are cultural components within a worldview
To be accepted as science, certain methods of inquiry are generally used (RNCS-p4)	Structure of science	Classical humanistic
Knowledge production in science is an ongoing process……..new theory replaces dominant view………..knowledge changes over time(RNCS-p4)	Structure of science	Science knowledge is tentative- challenges the notion that scientific knowledge is cast in stone
Learners develop the ability to think objectively and use a variety of forms of reasoning while they use process skills to investigate, reflect, analyse, synthesise and communicate (RNCS-p4)	Science/scientific skills development	Utilitarian
Scientific knowledge and understanding is a cultural heritage that can be used to: prepare learners for economic activity and self-expression; lay the basis for further studies in science; prepare learners for active participation in a democratic society that values human rights and promotes environmental responsibility (RNCS-p4)	Self as an explainer	Nationalism- identifying with democratic values; social reconstructivism; Progressivism
……promote understanding of science as a human activity(RNCS-p5)	Solid foundation emphasis	Egalitarian

Epistemology and the view of learning	Curriculum Emphasis Roberts (1983)	Ideological Influence
meaningful science education has to be learner centred (RNCS-p5)	Structure of science/ self as an explainer	Science as a social construct Progressivism- child centred pedagogy
...the acknowledgement of the limitations of scientific enquiry (RNCS_p5)	Structure of science	Other ways of knowing
The core knowledge…………70% of time for the Natural Science Learning Area…………the remainder 30%……..around contexts which are significant to learners and local community. These may be environmental, economic, social or health contexts (RNCS-p7)	Structure of science	Localized science Social/ Economic Efficiency
LO1: Scientific Investigations- the leaner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts (RNCS-p8)	Structure of science	Utilitarian Localized science
LO2: Constructing Science Knowledge- the learner will know and be able to interpret and apply scientific, technological and environmental knowledge (RNCS-p9)	Structure of science/ self as an explainer	Progressive Liberalism
LO3: Science, Society and the Environment-the learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment (RNCS_p10)	Everyday application	Rejection of absolutist ideology Different ways of knowing
Indigenous or traditional technologies and practices in South Africa were not just ways of working ; they were ways of knowing and thinking (RNCS- p10) *Different world-views are usually present in the classroom*	Science and technology decision emphasis	Acknowledgement of other knowledge systems
Assessment Standard: understanding science and technology in the context of history and indigenous knowledge(RNCS-p20)	Science and technology decision emphasis	Acknowledgement of other knowledge systems

Metaphysical-ontological (view of reality)	Curriculum Emphasis Roberts (1983)	Ideological Influence
It is challenged by those who argue that pure empirical science does not concern itself with the questions of meaning and value , and is therefore too limited a way of understanding the world (RNCS-p11)	Structure of science	Rejection of positivism/empiricism, possible influence of hermeneutics
Assessment Standard: categorizing information to reduce complexity and look for patterns (RNCS- p18)	Structure of science	Liberal ideas about education-overcome intellectual fragmentation
Axiology (politics, ethics and aesthetics)		
....the RNCS also places value on the learner be able to solve problems and think of ethical alternatives (RNCS-p10) *The scientific and technological choices people make reflect their values (RNCS-p11)*	Science and Technology Decision emphasis	Liberalism/ Utilatarianism Discourse ethic of Habermas (1984) Reconstructive Ideology
Assessment Standard: understanding the impact of science and technology on the environment and other peoples lives (RNCS- p20) *Assessment Standard: Recognising bias in science and technology which impacts on peoples lives (RNCS-p20)*	Science and Technology Decision emphasis	

Evidence from Policy Writers

In respect of the structure of science policy writers agree that they should contain the big ideas, with unifying statements and core concepts. Policy writer K-RNCS locates scientific literacy within the broader framework of critical outcomes and learning outcomes and feels strongly that ideology need not necessarily be political (i.e., a negative connotation) when viewed as a way of redressing the past:

> *Our overarching ideology is supposed to be the critical outcomes and I do to a large extent because this is a learning outcomes in every learning area, critical outcomes and to a large extent if I recall those learning outcomes emerged out of the critical outcomes and ours got three, about the personal skills, development of mutual understanding and getting into action about science, society and environment, it still a specific ideology and the ideology we want to create individuals that have a sense of themselves that is worth noting and that was the impression apartheid education created. In order for them to understand that you know I am something, I am worth something and I can do things for myself. For that reason the education or ideology is not necessarily a political ideology* (Policy writer K- RNCS).

There were struggles in defining the nature of science as is evident by the comment made by Policy writer O-RNCS:

We had discussions around the natural science, what counts as science, how is science conceptualized, in particular that brought in issues of indigenous knowledge and to what extent indigenous knowledge is science and the extent to which it is not and I think the discussion around it in a couple of paragraphs which you would now find in the document especially under the third learning outcome (Policy writer O-RNCS).

Policy writer E-on the RNCS comments on key aspects of the structure of science that has been accepted historically:

My sense of it was the idea was that outcomes can be done by learners and described by assessment standards at increasing levels of sophistication but all on the same outcome. That was a pretty fundamental part of the framework. Process skills were something which could be seen in learning area historically and Natural Science made quite a lot of use of that, at least in other countries. South Africa hasn't seen as much, but in other commonwealth countries the notion of process skills has a long standing and I think there was a lot of debate about it but at a pragmatic level a framework of process skills suggests to teachers the kind of questions theycan ask and components and activities that can be designed and taught. That was an important part of the framework (Policy writer E- on the RNCS).

On the axiological dimension of scientific literacy policy writer N-RNCS offers:

> *All values associated with Human rights, social justice, inclusivity, ethics and the environment. Clearly these social issues, social transformation was a big priority. It did influence but we achieved a balance. We were going to achieve social justice through the medium of science* (Policy writer N-RNCS).

Policy writer A- on the RNCS, proposes a post structuralist approach both to the development of skills and values:

> *Scientific enquiry and process skills (these follow rigorous methods of obtaining and verifying data, not necessarily emphasizing one approach at the expense of others or starting from a common position- e.g., deductive over inductive etc). Conjectures are very much part of such skills. Science attempts to arrive at the truth, but is not itself valueless. Who determines what 'science' is and whose contributions are included should be a matter all learners are exposed to* (Policy writer A-on the RNCS).

(c) Selection of Conceptual Knowledge

The RNCS policy document contains an entire chapter devoted to conceptual knowledge titled: *Chapter 5: Core Knowledge and Concepts* (RNCS-p61). A content analysis of the various conceptual areas per phase is presented in Appendix D. Selection of content was highly influenced by overseas trends and the 'road map' guiding the writing of the policy document, calling for a 'high skills', 'high knowledge' curriculum. This is in response to the 'content free' curriculum, where selection of content was left to classroom teachers who did not have the skills or guidelines to do so (i.e., devolution of curriculum design). Appendix D contains the 70% core conceptual knowledge that should be covered for the GET phase. Clear indications are given on the kinds of conceptual knowledge for each of the four broad themes: Matter and Materials, Life and Living, Energy and Change, and Planet Earth and Beyond. Each theme has sub-strands with a unifying statement that gives the depth and breadth of the sub-strand (see Appendix D). From a management perspective, Policy writer A- on the RNCS comments on the difficulty in establishing benchmarks at each grade:

> *And these principles, one of them, when we talk about high knowledge and high skill principle, one of those things we agreed was that those subjects that have international benchmarks and working groups could manage those whilst taking into consideration the South African context. We do have learning areas that do not have international benchmarks, like life orientation, is one, economic and management sciences, arts and culture. Even the natural sciences do not have what you call national benchmarks, in mapping you do know that eleven year old can do this, twelve, thirteen year old can do this. In science you know that the foundation phase learners are between seven and ten years so what can they do. So from the design point of view you must cater for that so that if it happens it makes it easier for teachers to integrate across the learning areas* (Policy writer A- on the RNCS).

Policy writers were working with the C2005 framework of the four broad themes, what was different was the choice of concepts within each theme, and a radical shift towards specifying 70% core knowledge and concepts that every learner completing the GET phase should be exposed to. Within this framework, and similar to C2005, there was no contestation on the selection of conceptual knowledge as is reflected by policy writers I, H and N- RNCS:

But we had agreed upon quite early that there were key concepts in science that we wanted to weave in and they were to fit into a logical progression and again there was enough of examples and models of where people were themselves. If one had to do a similar kind of thing here...but you see we weren't reinventing the wheel.....But the debates, in science there is a fair amount of agreement about the big ideas, the ideas to be taught (Policy writer I-RNCS).

Fortunately, I think the people on the committee had a fairly good idea about the nature of science and the latest theories on science teaching and learning but I think we didn't have too much of a problem in that regard. But we had a lot of discussion around issues on what should go into the curriculum, especially the content area, for e.g., if you take the section on evolution and creation, there was much debate about it and based on that we had taken decisions. But generally we had fairly common conceptual knowledge with regard to the content (Policy writer H-RNCS).

We had discussion on content and we had discussion on what the big ideas were, how best to sequence and so on and so forth and if you look at the our core curriculum and we go back to the four and one of the reasons that we said the four stands is that C2005 is exactly the same four strands and this was not seen as a new curriculum right and the best way to explain is to say that the NDOE in actually coming up with the NCS had accepted the fact that curriculum is not cast in stone (Policy writer N).

Policy writer E-on the RNCS comments on staying with the four themes for pragmatic reasons and an influence of international trends:

It was important to stay with the four disciplines. At least that would provide some recognizable continuity for people who have been on these training courses and so on. The curriculum materials have been written on these four themes, for continuity. We looked at it from a few points of view. Firstly, our brief was to strengthen and streamline the curriculum but not an overhaul of the entire curriculum. That was the first point. We have to understand that resources are a problem and a lot has been written on those four themes. So we need to take that into account. The second reason why we stuck with those four themes is looking at what is happening internationally. What is happening internationally is that those four themes are accepted throughout the world, in the UK, the US, Australia, New Zealand. They may not be titled the same but they are basically the same four themes. So those were the two reasons why we basically stuck with them (Policy writer E-on the RNCS).

However, the Africanisation of conceptual knowledge was left to the domain of classroom practice where the document states that:

> *The knowledge statements for the Intermediate and Senior Phases represent a notional 70% of the time in a Phase's Learning Programme. The other 30% of the time should be used to extend these minimum knowledge statement; alternatively, science content from contexts which are significant to the learners and the local*

community may be used. The contexts may be economic, environmental, social, or health matters, for example (RNCS-61).

This statement makes oblique reference to indigenous knowledge but how does the teacher explore the underlying structures of these knowledge systems is not made explicit. The concept of indigenous knowledge is explored to some extent in the assessment standards: *understands science as a human endeavour: Recognises differences in explanations offered by the Natural Science Learning Area and other systems of explanation (RNCS-59) and understand science and technology in the context of history and indigenous knowledge (RNCS-p20).* In the main knowledge is localized or learned in context rather than redefined. This view resonates with those articulated by policy writers involved in the RNCS process. Policy writer E-on the RNCS links this to defending what was valuable in C2005, i.e., devolution of curriculum and accountability for teachers. This is a profoundly transformative view – the shift from a prescriptive curriculum:

We had chapter 5 of the document that is separate from the assessment criteria. The statements in chapter 5 we believe should occupy 70% of the time and certain topics were taken up and it went with the compulsory section, where learners coming out of grade 9 should have engaged those ideas. By doing that you come up with the accountability question. You can actually ask are teachers doing their job, different from before. Are the kids covering this ground? And obviously in terms of outcomes. The outcomes must operate on the substrate. We wanted to I suppose defend what we saw valuable in the earlier version, C2005, which said to teachers you are responsible for curriculum development, you must connect the curriculum to children's lives and we were actually afraid that the MPC process was going to remove that. We wanted to safeguard that local relevance aspect; that's the principle of OBE, to want to select from the kids lives. In that 30% we are saying to teachers, I had a workshop on this at the SASTE conference this weekend, we are saying to teachers find something in your context that you can turn into curriculum, into the science curriculum. You have the process skills framework, you have the assessment criteria, you have the learning outcomes. Take a situation in your environment, you have mining, you have health, construction or telecommunication, something that the kids care about, something that the community cares about and make curriculum, so that the curriculum will not be the same all over the country. So that 30% we defended, it seemed odd to put a number to it but people do respond to numbers. We can go out and talk about that 30%, to go out and talk about something that was very important for C2005 (Policy writer E- on the RNCS).

Policy writers N and O-RNCS to the 30% provided for in the document for teachers to develop the curriculum from local contexts:

The curriculum must include internationally accepted concepts (Big ideas) for all so as to make us globally competitive; at the same time it should be flexible enough to accommodate local and topical issues that might arise from time to time e.g. Mark Shuttleworth, anthrax etc). Accordingly, the NS LA Statement has only these "big ideas" allowing the teacher to elaborate and take the curriculum in the socialization that s/he chooses; further the core concepts listed are meant to cover 70% of the notional time; the teacher must select the other 30% (Policy writer N-RNCS).

All learners should have the opportunity to be exposed to the "big ideas" of science. However,there should also be an opportunity to engage in local applications, and also content which may be very specific to a particular area. The document specifies 30% of the content to such local issues (Policy writer O-RNCS).

The two instances of some re-definition of knowledge that is not science comes from Policy writer A- on the RNCS and policy writer L-RNCS. Policy writer A- on the RNCS suggests the manner in which localization and re-definition can be achieved this can be achieved through the learning outcomes:

> *The National Education Policy Act defines curriculum in paraphrased form as selection from society of knowledge, skills, values and attitudes that must be handed to younger generations and could not be left to chance. The way this is actualized in a post-apartheid and post colonial South Africa is through specifying learning outcomes to be achieved at the end of the band (be it GET or FET band) and assess achievements of these learning outcomes through grade-specific assessment standards. Content to be used to achieve assessment standards is not prescribed. This allows for local content (including indigenous knowledge systems) to be part of the new curriculum. This framework allows national benchmarks and local variations in the same curriculum* (Policy writer A- on the RNCS).

Policy writer L-RNCS comments on science as a different way of knowing from indigenous knowledge, the practice in the past and in some policy documents has been to 'fit indigenous way of knowing into the science way of knowing', i.e., obtaining synergy between these two ways of knowing, with the assumption that science is a far superior way of knowing. He also comments on the limitations of science as a way of knowing which would be a powerful way for teachers to explore the meta-physical-ontological dimensions of phenomena:

You must be aware that the IKS are sort of a new approach. And there has been a lot of debate about that and about its place in science for all. ..... my own view is that science is a way of knowing, a very powerful way of knowing and it has got its limitations and we are able to differentiate astrology as science because we define a way of knowing science. If you have a curriculum which is teaching people science, astrology is a kind of indigenous knowledge, you know people when you talk indigenous they always think African and so on but even people in the west have indigenous knowledge. Some of it because it fits the label of natural science I get fears that you can confuse people into thinking it is actually a science. I am using astrology as an example. My view is that if we see science as a way of knowing and try and fit everything into it rather than recognizing it as indigenous or the power of the indigenous knowledge, we are actually increasing the hegemony of science, because we are saying, it is like me saying because I am a Christian and then try and fit all other religions into Christianity. I am not really recognizing them on their own and each religion has got its own way of connecting with the almighty. I believe that a system of knowledge is powerful, it should be powerful in its own strength not because it fits in with another. So those are my views but some people then thought I am saying indigenous knowledge is not science, it shouldn't be recognized and so on. I see them as powerful in identifying other beliefs which pupils bring into the classroom and if you teach them the way of knowing in the scientific way then its for them to see where the limits of science are, where the science is powerful and also see the answers which are given to questions which science might not want to address, you know the fact that science does not address life after death it does not mean that it is not an important question but some other knowledge system will address that in its own way. You cannot try and fit everything that is in that and fit it into the science, but you have to recognize it as a way of knowing which is alongside the science (Policy writer L-RNCS).

5.4.3 Summary

RNCS was intended to build on the vision and values (democracy, social justice, citizenry etc) of C2005. Its impetus was the over-design, lack of prescription and clarity, a design strong on integration but weak on progression and conceptual development- 'content free' curriculum of C2005. Whereas to some extent it has stayed with this basic position e.g., (i) in the four broad areas of conceptual knowledge; (ii) science as a socio-cultural phenomena; (iii) knowledge in science is tentative; (iv) value-ladeness of science; (v) environmental responsibility; learner-centered pedagogy; (vi) rejection of an absolutist ideology by acknowledging values and other ways of knowing; (vii) liberal ideas of education to overcome intellectual fragmentation etc, there has been significant shifts in the following areas: (i) a *Core Knowledge and Concepts* chapter that specifies

70% compulsory conceptual knowledge and 30% drawn from contexts- clear specification of conceptual knowledge and each strand having sub-strands with a unifying statement indicating depth and breadth of the sub-strand; (ii) a better balance between integration and progression (through the assessment standards); (iii) reduction in the number of outcomes; (iv) stronger focus on social justice and societal development- Human Rights and inclusivity as a special interest group was established to work alongside the working groups doing the writing; (v) a focus on the foundation phase; (vi) a high skills, high knowledge curriculum; (vii) acknowledgement of the limitations of science and science as not the only way of knowing; (viii) rejection of positivism/empiricism; etc.

Some of the complexities that have arisen are the perceived focus of collectivism (interview data) that was not supported by the policy document. There were struggles in defining the nature of science by some policy writers and scientific literacy. The document, in fact, does not define scientific literacy but does make explicit that it can be promoted through the three learning outcomes. The first two learning outcomes present the traditional definition of science. As in the C2005 process, there were struggles in defining an Africanised curriculum. There were oblique mention of IKS in the policy documents and interview data but the underlying structure of this way of knowing was not made explicit. In the main, conceptual knowledge was localized rather than re-defined. Like C2005, there is a focus on ethics but no discussion of its discourse.

5.5 Concluding Comments

In reforming the science curriculum there was limited influence from the science community driving the process – we have the 'science discourse' brought into the 'education discourse' by science educators much more than scientists. It is also interesting that the Science team took pride in standing somewhat at distance from the writing teams in other learning areas – in C2005, they managed to insert 'content'; in RNCS they made a number of new rules, such as the 70-30% rule in specifying content. However the RNCS is much like overseas in the way the four themes were chosen and the way in which assessment standards were written etc, and that the dominant view of 'equity' was access to 'world standard curriculum' (taught in local contexts). This chapter also alludes to the tensions between economic and democratic discourses between localization and globalization; Western and African Science and individualism versus collectivism. Other relevant philosophies/values that emanate from the data are science-centered versus human centered; science for all; science theory versus context; national values versus local; economic development versus equity; structure-prescription versus freedom. This chapter analysed the documents and interviews transcripts in terms of (a) their definition of scientific literacy, and (b) their ideological responses to the transformational agenda – especially in relation to equity. The definition of scientific literacy changed over these two reform periods (in terms of the wider definition of science) and how much it was 'African' rather than 'universal' (i.e., how was it different from overseas versions). The findings show that the RNCS definition of scientific literacy is not greatly different from overseas versions such as the Australian one – which also incorporated Science Technology Society Education, applications of science, Nature of Science, and Earth Science, but remained, centered on traditional topics and ideas from Physics, Chemistry Biology and Earth Science (classical humanist/ academic rationalist ideology). Thus few radical attempts were made in C2005 and NCS to localize the definition of science, e.g., in response to African cultures and rural experience (a social - reconstructive ideology). Thus the pressures for 'updating' were guided by overseas developments more than local conceptions of science, and equity was viewed mostly in these terms (access to the same kinds of science that exist overseas; globalization etc). In many ways, the C2005 definition of scientific literacy was wider than the RNCS definition. But even there, the writers' comments (in interview) tend to imply a 'universal' definition of scientific literacy (which they sought to express better than anyone else had) rather than a localized, contextualised one. Other findings in the conception of scientific literacy were the reconsideration of the nature of science (a shift from teaching science to teaching history and philosophy of science- this approach presupposes some student understanding of the science in question before considering the broader context in which science operates; which begs the question of how the initial understanding may be developed, from perceptions that privilege demonstration and experimentation to include other forms of reasoning); challenging the validity of the universal conception of science; shift from a content free (conceptual knowledge) to a balance in process and conceptual knowledge; some reference to the situated nature of knowledge i.e., knowledge claims can only be understood in the context of their generation; challenging the logical-positivistic nature of scientific knowledge. In the conception of scientific literacy the documents do not adequately address the Africanisation of science knowledge; an appreciation of the particularities of science practice for the purposes of curriculum development in the classroom; ways in which teachers could respond to different and conflicting explanations of scientific phenomena i.e. it presupposes a lack of conflict in alternate explanations to phenomena.

In terms of the analysis of ideologies, C2005 appears to have a strong humanist, multicultural and socially critical stance, the latter particularly in terms of learning. Analysis of the RNCS policy document show a similar pattern but tighter because of its prescription for 'high knowledge, high skills'. The 'shifts' were: 1994-1997- a shift from content -based science to OBE/learner centered science with a wide definition of science (through content still based on the traditional big ideas of science- although the team resisted pressures for a content free curriculum policy); 1998-2002: tightening up the degree of prescription (and clarity of expectations) through assessment standards; a shift to 'high knowledge', 'high skills' with a resistance of pressure for tight specification of content grade by grade. Thus in both processes the policy writers took the middle ground in terms of specifying content. In both processes the selection of content showed a strong international influence. In the next chapter, I will explore the extent to which these shifts are questions of clarity and implementation or a strengthening of the neo-liberal agenda of the state through technicist knowledge and state testing.

I conclude this chapter with this profound comment made by my supervisor:

> *We must not downplay the values and moral dimensions of scientific literacy, nor of the project to define scientific literacy. In time when the individual entrepreneur, rational self-interest, and neo-liberalism are over-running the world, should our response be to go with it? Go against it? Critique it? Encourage and enable students to critique it? Whose interests are we serving by*

these different choices (Professor Cliff Malcolm-personal conversation- 18 October 2003).

In Chapter 6 I document the policy process as it unfolded during these two periods of curriculum reform and use the analysis from both these chapters (Chapters 5 and 6) to draw out emerging regularities for another level of analysis…

Chapter 6

Digging deeper: Excavating the Policy Process

The Rules of the Game

> *But another thing you must understand: the terrain of struggle was different. You get terrains of struggle in the streets where the power of the mass counts, then you have terrains of struggle which are intellectual, where you got a committee of ten people who are brought together to do something where, in that kind of forum, the numbers don't count, the muscular strength doesn't count. What counts is your intellectual strength. So even though we were in minority we managed to make sure that the new curriculum was not seen as disinterested [in social values]. It was part of the transformation, it was part of identifying with democracy. It cannot remain neutral. Either you are with democracy or you are not with democracy. To be with democracy, what does it mean in science? It means you must acknowledge that there are many differences in the world... There are many ways of doing science, they need to be accommodated. So that's why you will see we were trying to bring all these issues into Curriculum 2005 (*Policy writer A-C2005).

6.1 Introduction

In this chapter I use the techniques of policy archaeology and policy genealogy to excavate the policy process. This chapter digs deeper, examining the processes of policy development, including the roles of individuals and structures and how they interacted. My intention here is to dig deeper into the policy process and understand the rules of the game of how the documents came to be, to unearth how the details of the particular structure has been resolved. I will explore: who were the people involved, the structures that constrained or facilitated the process and the form of policy documents. Recall, from the discussion in Chapter 3, that policy archaeology operates in four arenas: (i) the education/social problem arena: the study of the social construction of specific education and social problems; (ii) the social regularities arena: the identification of the network of social regularities across education and social problems; (iii) the policy solution arena: the study of the social construction of the range of acceptable policy solutions and; (iv) the policy studies arena: the study of the social functions of policy studies itself. This chapter will be limited to the first three arenas in trying to excavate the policy process. Policy archaeology, refusing the acceptance of social problems as natural occurrences, examines closely and skeptically the emergence of a particular problem. It asks specifically:

(i) By what process did a particular problem emerge (i.e., how did a particular problem come to be seen as a problem)?

(ii) What makes the emergence of a particular problem possible?

(iii) Why do some problems become identified as a social problem and other problems do not reach that level of identification?

(iv) By what process does a social problem gain the gaze of the state, of society and thus, emerge from a kind of social invisibility into visibility?

The second arena of policy archaeology suggests that there are powerful grids or networks of regularities that are constitutive of the emergence or social construction of a particular problem as a social problem, regularities that constitute what is labeled as a problem and what is not labeled as a problem. This arena seeks to identify these regularities. The third arena involves the study of how the range of possible policy choices is shaped by the grid of social regularities. Policy genealogy seeks to ask:

(i) how policies change over time

(ii) determines how the rationality of the policy production might be problematised, and

(iii) how temporary alliances are formed and reformed around conflicting interests in the policy production process.

Data has been gathered from interviews, questionnaires and curriculum policy documents. In policy research, power relationships are part of the data collection as well as the policy process. Participants in the research included curriculum leaders, advisors and bureaucrats highly skilled in the politics of interview as they are in the politics of meetings (Taylor *et al,* 1997). The interviews occur in a situation colored by perceptions of expertise, ego and gender (Roberts 1981; Le Compte et al. 1992). I approached the interviews with sensitivity to these issues, seeking to find ways through them according to the people involved, in ways that provided thoughtful and insightful responses. In the analysis of the data, I sought not so much 'triangulation' of ideas but 'crystallisation' – statements from one or another interviewee that seemed to bring together various pieces of evidence (from a number of interviewees) in ways that captured the meaning of that evidence. I attempt to understand and explore the policy making process through the eyes of these 'chosen individuals' and capture the emotions and frustrations as they dealt with conflicting demands. One of the issues in this study is that the powerful players and shapers were outside the Science Team – these were the ones who set the framework in which the science team operated. This study focuses particularly on the science writing team. Recall from Chapter 5, that the team had no trouble with the ideology and purposes of the larger frameworks, but were prepared to 'do their own thing' within that framework. Although the larger frameworks and broader battles were decided outside the science team, this chapter shows the interaction between individuals and 'structures', and ways in which structures were used/subverted were significant in terms of the writing of the policy document.

This chapter is organized as follows:

In **Section One** I present the policy making process for C 2005. I explore who the policy writers were, the way in which the policy problem was constructed socially, what regularities made it possible for this particular policy problem to emerge, the policy choices that were made and what shaped the policy choices they made in writing the policy document. The 'stakeholder approach' to policy making adopted by the post apartheid-democratic government in 1994 led to an elaborate, multistage process that was, in intention at least, an attempt to involve as much input from the public as possible. In this section I profile the key individuals that were involved in conceptualizing and writing the policy document and elicit reasons why they feel that they have been chosen to be part of the process, I present critical incidences in the experiences of policymakers that brought the emergence of the policy problem, highlight what they see as strengths and weaknesses to the way in which the policy making process is structured and document their perceptions of the policymaking process.

In **Section Two** I treat the new individuals that were involved in developing the RNCS to the same kind of analysis as in section one. I draw on the experiences learnt from the

C2005 process and how that has impacted on the structure of the process in developing the RNCS.

In **Section Three** I present the recurring issues and patterns of the two processes that seek dissonance or commonalities in each in an attempt to draw out policy lessons that inform the structure of Chapter 9. I explore how policies change over time; determine how the rationality of the policy production might be problematised, and how temporary alliances are formed and reformed around conflicting interests in the policy production process.

Section 1: The C2005 process

6.2.1 Who were the policy actors and how were they chosen?

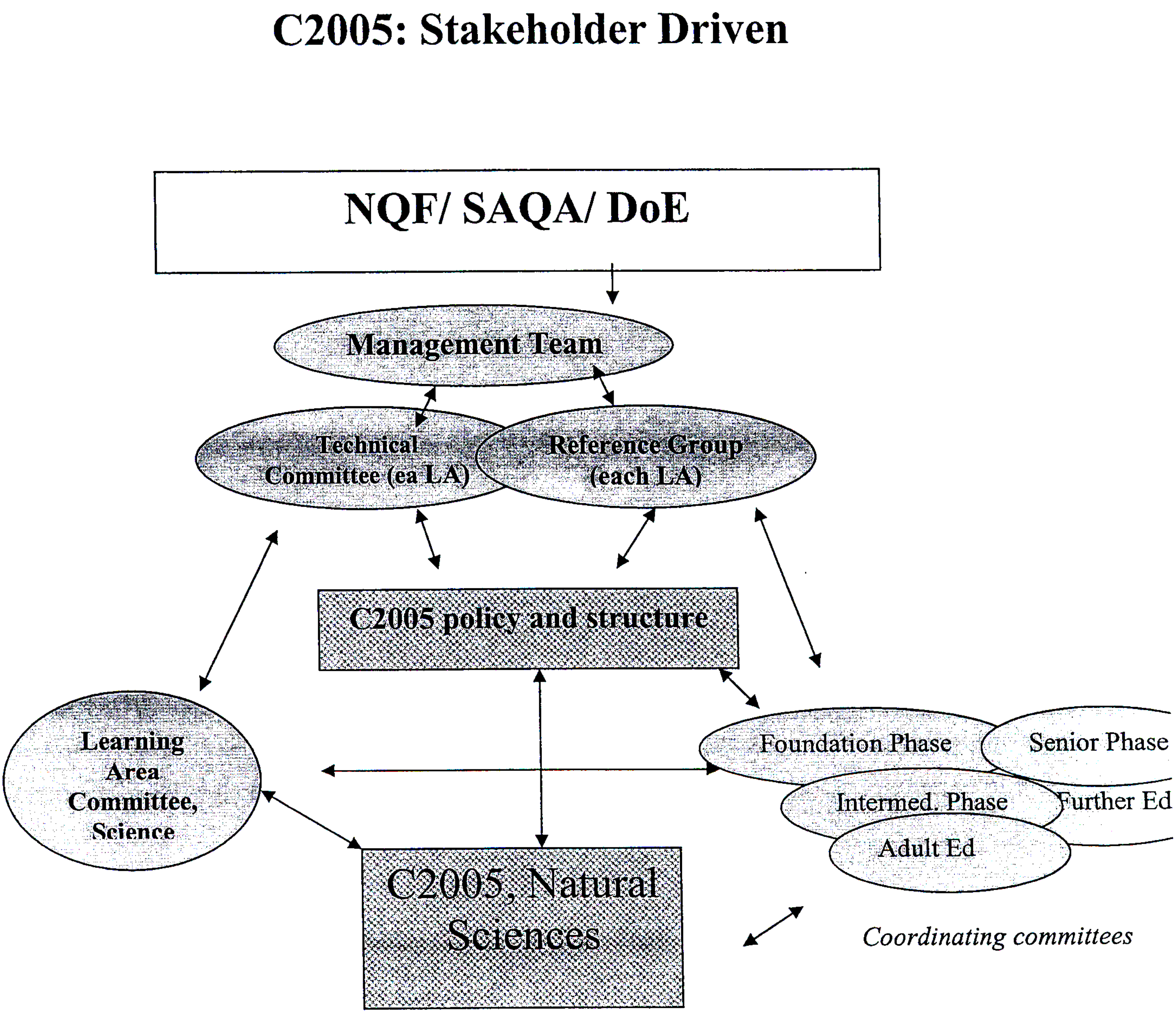
The national learning area committee for the Natural Science Learning Area that was formed in 1997 comprised of a large group of interested and invited individuals. Policy writer E- C2005, who was involved at the stage of the National LAC, describes the 1998 version of C2005 as partly a sort of accident of History and partly an inevitable consequence of a process that needed to happen and happen immediately:

> *The accident of History was that in the early 1997, the LACs, the broad framework had been laid and in Gauteng and in all the other provinces. The idea was that this process be driven by stakeholders. There was also an intention to develop district LACs. Long before they had a chance to meet, they were overtaken by provincial LACs. Provincial LACs had just begun to meet when the O Monde Sept 97 meeting took place and provincial LACs were overtaken by National LACs, which were pulled together from wherever, anyone who was available, rather than experts in the field and inevitably it turned out that there were no teachers in that group and that's the accident of history side of it. I think the other part is, that teachers, the imperatives for teachers are to deal with the needs of pupils, school administration and so on. Very rarely do teachers have time or the inclination or the vested education to think about broad curriculum issues. It shouldn't be like that* (Policy writer E- C2005).

The C2005 policy-making process for the Natural Science consisted of the National LAC, a large group of about 50 individuals who were invited to two or three National workshops. As is evident in the remarks made by Policy writer E-C2005 there were no teachers in the group. The structure did not allow for that since teachers were 'not available' to participate at this level. Also they were perceived to not have the skills to participate in curriculum issues. This has implications for devolution of curriculum that was on the curriculum agenda at the time. This broad National LAC appeared to be a fluid committee, i.e., although registers were kept during these workshops, individuals were difficult to locate and different individuals were in attendance at different workshops. I was able to locate some of the individuals and in Chapter 4 I profile six of these individuals who were willing to be interviewed. The names of the policy makers are not indicated so as to protect anonymity. As a small number of individuals participated in the writing process and these individuals could be well identified by their profiles, I masked their inputs by referring to them in pseudonyms so that consistency in their responses could be traced but not at the expense of anonymity. The seventh policy maker was interviewed but was not willing to be profiled. Members were nominated by various stakeholders to serve on the LAC, some members attended on their own accord. The brief of these eight National LACs (one for each learning area) was firstly, to write a rationale, and secondly, to identify learning area outcomes that reflect the critical cross-field outcomes as formulated by South African Qualifications Authority (SAQA). To adhere to the principle of an integrated approach, five co-ordinating committees were established, one each for the Foundation Phase, the Intermediate Phase, the Senior Phase, Further Education and Training (FET) and Adult Basic Education and Training (ABET). The task of the Co-ordinating Committees was to identify cross-curricular issues in the eight areas of learning and to do the clustering of outcomes supplied by the National LACs into focuses for the eventual development of learning programmes. The Co-ordinating Committees each comprised more or less 26 members representing the various stakeholders. To take the work of the five co-ordinating committees further towards one broad curriculum, a Technical Committee was established. Nominations for appointment to the Technical Committee were invited through the Government Gazette. The Technical Committee was assisted by a Reference Group, comprising three members of each LAC, as well as two practising teachers nominated by each of the eight LACs, and one ELSEN representative.Together with the co-ordinating committees, these three structures eventually developed all the inputs referred to above, into the curriculum for General and

Further Education and Training which was announced on 24 March 1997 (DOE, 1997). The technical team for the Natural Science learning area consisted of three members. The third member, a female department official declined the invitation to be part of this research project. Below is a schematic representation of the process:

Fig D: Schematic representation of the C2005 process



Members of the technical committee were selected from outside the school arena. They were however assisted by the reference group that did comprise classroom practitioners. The technical committee was tasked with the writing of the document. Collectively the profile of members of the committee and the intention of the Department of Education to have a broad consultation process did embody the principle of a stakeholder driven process but the extent to which all stakeholders were meaningfully involved is evident by:

> *So the stakeholder driven was a rhetoric, the reality was to get something out quickly. There is a political necessity and we had to deliver* (Policy writer E-C2005).

Lungu (2001) agrees that the weakest point in the policy process was the engagement of stakeholders in the process. It is not clear to what extent teachers were represented, because press reports at the time indicated that a large section of teachers, for example, had problems with C2005, largely due to a lack of training in OBE but more so due to the threatening policy of rationalization of teachers. It may also be that representation of stakeholders was part of the educational elite in the country-the group that understood and could debate intelligently about the philosophy about OBE. It is not clear to what extent C2005 massified the participation of stakeholders. The technical committee rather than the stakeholders drove the process. There is also doubt as to how much of the submissions to the process had informed the process or the policy documents:

I think National Education would claim that there was. But the meetings, 90% of such meetings were taken up with presentations and explanations of what things were and you can't expect people to make a response that is not clear. Well there were comments and submissions. There was input but there was no place to put it in. The process had rolled on (Policy writer A- C2005).

Policy writer B- C2005 speaks about how in theory it would appear as if a broad as possible public was consulted but the practical realities of dealing with the submissions and time pressures weighed the process down:

There was a lot of response to the documents that were initially floating. I am not sure whether the documents were floated as broadly as the new governments policy development process required. But there was a lot of talk about how policy would be developed and in fact in many areas policy was developed through the most broadest process that happened anywhere in the world and many policy makers were coming in *and looking at this and saying wow, you guys are really doing something new here. While the education documents, the curriculum 2005 preliminary documents, the promulgation of that, the technical committee in early 1997, the documents went out for public comment and debate and then there was responses brought back and these responses which came back to that reference committee ....looked at that stuff and said there's too much work here and they just threw it away. .... there was not a single thing in that document that had any influence on the documents that were promulgated and so that part of the process was corrupted by the need for speed* (Policy writer B-C2005).

The elaborate and sophisticated policy development process post apartheid, suffered at the hands of political necessity to deliver. There was also a feeling, particularly amongst those from the NGO sector who had many years of classroom experience, expertise and the political right to give input, that the consultation process excluded them:

> *The other thing that was happening was that there was at least 15 years of classroom experience among the NGOs. Quite apart from that right through the 1980s they were thoroughly disliked by the education authorities and yet nonetheless managed to bring about quite a lot of change in the classroom and learn quite a lot about what works and what fails. We were never consulted. We were eager to be consulted but they told us they'll call us in three to four years* (Policy writer A- C2005).

Policy writers cited the following reasons for been chosen or interested in the process: (i) they represented science NGO's; (ii) they were invited to a C2005 meeting as chairperson's of a provincial LAC; (iii) as part of a stakeholder group- union; (iv) experience of years of research in science classrooms; (v) Some cited being available as is evident by:

> *The other reasons are because I live in Johannesburg and I was available, that I knew people who were involved. I am actually saying this to illustrate the contingent nature of the process. Other people could have been involved but they didn't have the time, or they lived in Potchestroom or Bloemfontein or something. What is in the final policy document is who is available to take it to the next stage. People made themselves available they felt committed to the process. There were other people for e.g., who lived in Cape Town who were also very committed but couldn't come up here* (Policy writer E- C2005).

(vi) Some policy makers cited reasons of being involved in a number of science initiatives in the early 90's and before. Some of these initiatives were the NEPI (National Education Policy Initiaitive) process, the STEC (Science and Technology Education Commission) of the ANC that organised the 1993 Science and Technology Education Conference and the CEPD (Centre for Education Policy Development) initiatives in 1994 and 1995. Policy writer A- C2005 speaks of his active involvement in science education that has led to his appointment to the curriculum committee as a Department official:

....and for four years in the College of Science I experimented with alternative strategies to teach and learn science (by the way I got a distinction in a Science Education module called Alternative Strategies for Teaching Science), I was part of a four-person Task Team of SYSTEM that piloted alternative science, mathematics and technology curricula for four years under Minister Bengu (1995 to end of 1997), I was the founding author of a motion to disband the old associations for physical science and biology at the biennial science and mathematics education conference in 1995 – the overwhelming majority of the delegates approved the motion - as a result, work has been done in provinces to bring about the new South African Association of Science and Technology Educators (SAASTE). I was appointed for four years by Minister Ngubane to serve as a member of FEST (Foundation for Education, Science and Technology) Council (1996 – 1999), due to my experience and expertise I have been appointed by Minister Asmal to the following three structures: C2005 Review Committee, Ministerial Project Committees for GET and FET Schools (between 2000 and now) (Policy writer A).

In response to questionnaire item 1 on the policy making process (Part B): *Representation was based on expertise more than affiliations with particular groups*, two of the respondents had indicated '*often true*', two '*only sometimes true*' and two had indicated *'not true'*. From the comments made earlier about why these individuals were involved in the process, representation was based more on who was available, enthusiastic and whether it was convenient to attend the meetings rather than expertise. Nonetheless expertise cannot be ruled out as a key factor in the group combinations but this occurred as a matter of coincidence rather than intervention. In response to item two (*The process of consultation was democratic)* policy writers took the middle ground with three of them indicating '*often true*' and three indicating *'only sometimes true'*. This was probably because the intention of a democratic consultative process was there but the reality saw differently as is evident in

> *... we used to have big arguments about the difference between representation and participation and they made every attempt to make it representative but they*

didn't encourage participation, real participation. So there were times when it was very democratic and there were times when it wasn't. (Policy writer C-C2005)

6.2.2 How did the policy problem emerge and what regularities made it possible for this problem to emerge?

In Chapter One, an account is given of the context of reform. In chapter 5 (see section 5.1.1), I presented what policy writers see as the policy problem. In this chapter I will explore how the policy problem has become socially constructed. I also draw out **regularities** that made it possible for the policy problem to emerge and the range of policy solutions offered and how these are constrained by the grid of social regularities. The problem that this policy is meant to address is messy, complex and large. This section offers various problems within the policy problem and seeks to relate the micro and meso problems to the macro problem. The policy solution: that of curriculum reform, i.e., the design of the curriculum based on principles of OBE (learner centeredness, devolution of curriculum and integration) occurred in response to pressures that I would posit operates at three levels that make it possible for this policy problem to emerge. At the macro level these pressures are (amongst others), skills based training, commodities and marketization, consumer confidence, economic problems (government debt etc), social problems (inequity, no infrastructure, fear of instability, health etc). At the meso-level of curriculum development the pressures to be identified (amongst others) are education versus training, poor learner achievement, poor teacher training and development, portability, overhaul of post apartheid curriculum and inequities in educational provision. At the micro[1] (at the science curriculum development) level these pressures are the poor state of science education, long periods of review, incongruence with international trends etc. Policy writer A-C2005 comments on the disjuncture between education and training and acknowledging work place learning:

During the early 90s there had been quite a lot of discussion on the disjuncture between education and training so there were a number of people who wanted to see those two things linked again. There were also concerns that date back to the early 1980's that people in industry were on the job acquiring a lot of experience but it was never going to be acknowledged particularly in wage terms because there was no qualification to show

[1] The readers of this thesis are once again reminded that this study focuses on the policy writing team, i.e., the micro domain of policymaking.

for it and I think another concern was a linked concern, was a huge number of people who had gone almost through to matric but have been in school for 10, 12, 14 years and nothing to show for it. So the talk was of ladders that people could climb and there were parallel ladders. You could get off one ladder and onto another one and then after climbing a few more rungs you could get back to the first one, go out formal schooling , go into training and come back in again to formal schooling, spend some time in Technikon, go onto university and have the your technikon credits recognized there. It was those kinds of concerns for adult education. I don't think you can see the science curriculum apart from that whole political drive, portable credits, the NQF, on which you could get a science education whether you are in school or out of school, whether you were young or old. To do science, to do maths, to do everything else those were the concerns at the time (Policy writer A-C2005).

Policy writer D-C2005 is also of the view that one could not separate science development from the wider debates going on about curriculum. He emphasizes the outdated apartheid curriculum and its underpinning philosophy, dominant theories that underpinned learning and teaching and new trends in science education:

I think I see this as a wider need of education you know our education needed to be done away with rather and a new one put in place. It wasn't particularly the science curriculum but obviously a strong political impact to the changes in South Africa, but apart from that I would say it .....I said this in the questionnaire that I e-mailed as well that the curriculum in South Africa must become more outcomes based as well, the theory and philosophy underlying the curriculum were outdated. In South Africa it wasn't much in behaviorist terms which of course is so in many countries as well, a kind of behaviorist model behind the idea what knowledge is and the transfer of knowledge so in that respect the curriculum must be informed by theory and for science the curriculum was very much a traditional curriculum in terms of being more for academic studies at tertiary level rather than its delivery for use of science and its knowledge. Science in society is a natural phenomenon, be it cultural phenomena etc, etc, etc. We shouldn't be part of any one learning in the country, it must reflect the composition of the society. And the traditional curriculum was content oriented, concepts and definitions without much contextualisation (Policy writer D-C2005).

Policy writer A speaks about the immense initiatives that were working post 1994 in the area of curriculum and political struggles under changing management. He sees the labour organization as a crucial group that shaped OBE, with the ANC making strategic inputs towards an integrated curriculum(e.g., by combining science and technology):

If you look at the Education Manifesto of 1994, from the Education Renewal Strategy of the previous dispensation and the liberation movement was the other you compare these documents and see for yourself what was the negotiated settlement in curriculum, in other words, what part of the...., what do you call it, you know after the education renewal project, the COMSA document, the curriculum model for a new South Africa. It is not in the COMSA document, its not in the ANC document, it is the union movement, the labour movement. Like the OBE came from the labour side you see. Now the ANC side they argued for a science and technology as an integrated in the primary school. The argument there they presented both ideological and resource arguments, not enough human resources, physical resources to cope with a new learning area called technology. That you must understand is within the historical and political climate. And how politics shaped the development of post apartheid curriculum. Now the over-design I spoke about, now the leadership. After 1997-1998 the old leadership started taking packages, you know, and by that time, 1997 the Council of Education Ministers took a decision to implement this new curriculum by 2005 hence the name C2005. Then they were satisfied that this was in the system and running now. Come 1998 it will be implemented in grade one. (Policy writer A-C2005)

Policy writer B-C2005 also comments on the important role of the labour organization:

Going back to the Department of Labor- Generally labor wanting to try and narrow the mental-manual gap in the curriculum. In September of 1996 we had a lot of speakers, we had the people from the Scottish Vocational Educational Council and we had some Australians and so on all talking about the process and the idea was to try and structure OBE and what it would look like and then we got together in subject areas, it was as that point that we actually named the thing the Natural Sciences, because they wanted to talk about science, so we gave it that name and I personally kind of pushed that and pushed that so we could include all the sciences in that. And at that stage we had what we loosely called Learning Area Committees (LAC). (Policy writer B-C2005).

Pre-1994 curriculum development was the privilege of a minority group of individuals. Policy writer F-C2005 alludes to a more inclusive process:

Well I think there had been pressures to, in terms of the natural sciences, to restructure the curriculum because it was very outdated but I think there was some strong political pressure, but the strongest pressure came from the change in Government – the need to create a curriculum that would address all groups- meet the needs of all groups-I think there was both an educational and physical need for a new curriculum.(Policy writer F-C2005).

6.2.3 Shaping Policy Choices: What happens in the policy environment that led to the choices made?

Rules or Regularities: Constraining/ Enabling??

Policy makers were asked to comment on the strengths and weaknesses of the way in which the policy making process was structured. The focus/point of entry is on the personal contributions, struggles and experiences of a range of individuals in the course of developing curriculum policy within a structural framework. Policy writers attributed weaknesses to the process because of the following factors:

a) *Time Constraints*

The policy making process is characterized by the break-neck speed by which it was developed with little reflection on the consequences of what was being done, coupled with the ad-hoc nature of the process as reflected poignantly by policy writers F and C-C2005:

> *Well first of all it was impossibly fast. It was irrationally fast and that was a political agenda. And there was no time to really think about issues, to disseminate stuff and to work with teachers and debate it with teachers at length before moving on to the next stage. So things were done in a rush. (*Policy writer F-C2005*)*
>
> **And,**
>
> *I think the time frames were impossible from the start. I think the decision makers at that time had not thought through what it was going to take to get people on board and prepared and undermined the credibility of the whole thing because everybody was saying the time frames were impossible. The consequences of that was that the people who were involved in socialization and arranging and guiding the process was so busy dealing with the details that they didn't themselves have time to think things through. And the absence of guidance, please don't misunderstand me I am not blaming anybody, it was a consequence of the time frames that nobody had time to think* (Policy writer C-C2005).

The LACs were given the brief to generate specific outcomes for their learning areas in a period of only three weeks. Interviewees felt that this could not measure up to comparable work in other countries, which, with curriculum development units in place, took five to ten years. Policy writer E-C2005 adequately captures the adhoc nature, the lack of clarity of what the LACs were expected to generate and the political tensions at the time:

> *I think it was a very poor structure. It was extremely ad hoc, the bottom line was that a document, almost any document had to be produced by a deadline, by Feb 1998.The group was pulled together at Burges Park Hotel in Pretoria. We were there for the whole week. I came in towards the end of the week. We had a few Canadian consultants working with all LACs, not particularly science and when I came in it was at the stage you know, I said there were twenty desirables that emerged from the O Monde meeting, a rationale, the kind of thing that should happen. The group was given the job of taking the twenty and reducing them down to a much smaller number not less than five. And we did not know at the time but they were to become the specific outcomes (SO). So we started at about nine o' clock in the morning and the twenty or so items were moved to the crunch and we got them down to about nine and then it was half past three for report back. If we had till 5 o'clock we could have got them down to six. I think it was half past 3 and what went out into the world were the nine SOs, and of course that was what was happening with the other groups so we ended up with 66 SOs in this way. Anyone who was not thinking of SOs was seen to be sort of undermining the process, being reactionary and so on. So it was rather an absurd process and I described it in some detail for the paper I wrote for the later review. So that was how we ended up with nine SOs for science (*Policy writer E-C2005).

b) Inadequate Conceptualisation of Curriculum Design by Department Officials

Interviewees cited immense pressure from the Department of Education to design the curriculum in a particular way so that South Africa could compete globally, without fully conceptualizing the design features and the consequences that would have in a South African context. Policy writer D-C2005 reflects on a profound statement made by John Bray, an international consultant to the process:

> *...we had inputs from around the country and we were reading documents from other countries and pressure towards a ideal curriculum to get back into the world, too much into the world has been in a western context, that was my understanding of in Australia, America, Canada but South Africa isn't like that, its very much different. So what you have John Bray, they invited him to speak at one of the conferences at SAARMSTE, his message was you know how many ingredients are common for you to put together for a curriculum to have outcomes, assessment criteria, performance indicators, you know what do you need but really what can it do without. Now I thought that was a very important message that he said to us.* (Policy writer D-C2005)
>
> Officials of the Department that conceptualized the process were also unsure along which path to thread as reflected by:

And I remember ……. I had an argument with her, it was mainly her, you know she wanted to show learning by creating more and more intricacies in the curriculum. I think that was a way to solve problems, you know you've got a problem create another layer in the curriculum, you've got another problem then create another layer in the curriculum. I think that probably wasn't really the right approach (Policy writer D-C2005).

Politics and the need to conform to a particular model had been over-ridden by a lack of vision of what would best be appropriate for the country. This was an agenda from which it was difficult to get off and gear it into somewhat other directions as is evident in:

You know the co-ordinates on the grid where SOs and under each SO comes the range statement, under that the assessment criteria. The grid became a monstrous maze and quite unmanageable. The logic had been, the logic had more or less taken been taken over and the grid had to be proliferated and proliferated. That's the process..... on the one hand{we had) very serious doubts about what was happening and the way it was being handled and at the same time they were acutely aware that it was a historical opportunity which may never come again. May not come again for 20 years and even though it was so badly managed you had to stay in it because you might not have any other opportunity. So, the people like me who worked in NGOs for much of our professional lives we knew what the situation was out in the township, we wanted to be seen, to be heard. On the one hand we were trying to make useful constructive input and on the other hand some of us were writing letters saying please don't do it like this, its not going to work (Policy writer E-C2005).

Policy writer B-C2005 sees the intervention by the Department officials as not necessarily a weakness:

It was restrictive in the sense that we had people from the Department with a particular departmental agenda whatever that was, whether it was political or whether it was intellectual, whether it was bureaucratic or whatever, they kind of channeled this process, now that was not always a weakness, there had to be some channeling otherwise it would have gone off in a million different directions, but yes, there was this attempt to integrate and there were these people that made sure we did integrate, but I don't think it got beyond the level of rhetoric because I think the LA groupings did their own thing anyway.

c) Group Representation and Restriction of experience

Some members of the group expressed doubts on the qualifications and the experiences of those that were involved in the process as is evident by:

> *They had to go and ask other people and that's fine and I think the report that came out of that process was remarkably good. Actually at the beginning we were*

very uncertain as to whether the people that were in it were qualified in terms of their experience to do this kind of work (Policy writer C-C2005).

d) *Period of Intellectual Growth*

It was of course, a period where people could learn, as they drew on their own experience and capitalized on the experience and expertise of others. There was an attempt to integrate the curriculum as a whole where the LACs and the technical team met together in one venue for a specific learning area, where people could learn from each other, and were challenged by the writing process. There were also plenary meetings of technical teams of all the learning areas where the power of numbers and intellectual strength counted with a realization that this was a important process in curriculum history to determine what is appropriate for the country as it is eloquently articulated by:

I think also learning areas have different needs and approaches ………….and so the power of getting numbers in your committee that itself probably sorts itself out again, that came in there but not always emphatically and at times perhaps it kind of came to a no go area rather than open dialogue in terms of what was more appropriate for the country (Policy writer D-C2005).

For the policy writers the process did not end there. The LACs worked hand in hand with the technical committee. There were regular meetings with their constituencies, a to and fro process of giving information, having workshops and getting feedback to feed into the process. One such meeting took place in KwaZulu Natal[2]:

the three of us undertook collectively, that whatever we learned there we will come back to KZN and within two weeks we would call people together, we learn stuff we do stuff, we bring it back we test it, we had at one stage about 170 people and between 20 and 140 would pitch up on any given day. And we would work with them and get ideas and then we would go back to Pretoria, and whatever happened there we would have a meeting within two weeks with the people and what was happening was we were developing each others understanding by talking about things that were new to all of us and we'd say now what do you think they mean by that and we'd sit together and try and unpack it. That was probably the most useful thing that we ever did (Policy writer C-C2005).

[2] KwaZulu Natal is one of the nine provinces of South Africa.

What were the conditions that regulated patterns of interaction of those involved?

In addition to imposed frameworks by government agents (and the rationality of government) , policy writers were asked to comment on frameworks within the writing team itself that constrained or enabled policy choices. The response to item 4 (*Some members of the team dominated the discussion and strongly influenced what was put into the final policy*, four of the respondents indicated *'often true'*, one respondent indicating *'only sometimes true'* and the other *'not true')* and the response to item 8 (*Some members of the team had vested interest in channelling the discussion around certain values,* two of the respondents indicating *'always true',* three *'often true'* and one *'not true')* is inconsistent with the inputs received during the interview. Policy writers felt that there was not much political or practical tensions in the group, rather some very good discussions, criticisms and debates in the groups when they went about some issues, for e.g., there were debates around language were the nuances and subtleties of the language in which documents were written, created a problem in interpretation. There appeared to be a reasonably common understanding of what the problems in science education were and how the group was going to further science education. However there was a feeling that the smaller, technical committee did not represent the group discussions and the thinking of the larger LAC, compromises were made which appeared to have made the effort of the LAC somewhat futile:

> *And you know when we put together all those outcomes we put together a lot of really valuable outcomes and one of the things that made us really angry was when the stuff went to the technical committee, they re-constructed those outcomes, there was no consultation back to the original working group. So here we had a technical committee of 12 and three were science education teachers, I didn't necessarily feel that the three represented us. What came out was OK but I am not sure that it was entirely represented our thinking, but it was OK. But I think those issues around that consultation, this tendency to rush ahead* (Policy writer F-C2005).

Nevertheless in the main five of the respondents indicated that compromises of competing interests and demands did not reduce the integrity of the final policy document (*'not true').*There were discussions around theoretical issues of worldviews and environment and the claims of science, with a lot of give and take:

> *We kind of negotiated positions, a bit of horse-trading. You know, the kind like I will accept your SO if you accept mine. People like……… and I were concerned about the worldview aspect, where you look in learning science you don't necessarily have a scientist worldview. They might come from a background that is far more spiritual or which the supernatural would count for much more in terms of explanations than certain mechanical things from science for e.g. And you have a meeting of cultures here. Science has a culture and of course people in South Africa have cultures and we wanted to sort of bring that up to the surface. Where this comes in distinctly is SO six, it has been watered down a bit to say something like....an understanding of the relationship between science and culture. Then there were other people who were saying that the environment is what counts, lets have a theme on environment. And other people would say if kids cannot understand the difference between melting and dissolving then we were not going to get very far. There was a big debate about that but there wasn't time for it* (Policy writer E-C2005).

And Policy writer B-C2005 acknowledges that there was a healthy balance of ideas:

> *So there were those debates but many of these get resolved by some kind of compromise, people kind of giving away on another point of view if you can give away on mine kind of thing. We got a reasonable amount of balance there, so I don't think any of them were particularly dominant.* (Policy writer B-C2005)

In response to item 9 (*The task team/ committee operated within an agreed framework of: 9.1 purposes/goals*, two indicated '*always true*', one '*often true*' , two '*only sometimes true*' and one '*not true*'; *9.2 learning theories*, one '*always true*', one '*often true*', three '*only sometimes true*' and one '*not true*'; 9.3 *content*, one '*always true*', three '*often true*' and two '*only sometimes true*') the majority felt that there was some kind of agreed framework on purposes/goals and content, one policy maker felt there was a sense of making the road while walking. There was a sense that there was a framework but not a very strong one, there was however much discussion on content as is evident in the response to item 7 (*There was extensive discussion around scientific knowledge and curriculum content)* with three respondents indicating '*always true*', two '*often true*' and one '*only sometimes true*'. Also in the main policy makers felt they were adequately resourced and skilled to contribute to the process as is evident in item 3(*Collectively we had rich resources, information and skills to formulate the policy)* with three respondents indicating '*often true*' and three '*only sometimes true*' and item 6 *(I felt that I was not able to contribute significantly to the process of policy formulation)* with three respondents indicating '*not true*' and three '*definitely not true*'.

Implementation issues are ideological (when one looks at the distinction or not between policy development and policy implementation), but more so it is about process: the ways the writing team managed pressures to have the document implementable or not. It was clear that implementation was not a major concern during the C2005 policy making process (*Item 5: Much of the discussion revolved around implementation issues and what needs to be done to lay the foundation for implementation.*) with two respondents indicating '*not true*' and four respondents indicating '*definitely not true*' to the questionnaire item. The response in this item is consistent with data from the interviews. Respondents were posed the question:

> *How would you respond to the comment made by Jansen in his book: 'Implementing Education Policies' that policies (C2005 being one of them) produced in the 1994-1997 period were highly sophisticated and merely symbolic or visionary rather than being intended to bring about any fundamental change in classrooms? Did the committee discuss the tension between a visionary symbolic policy and a practical implementable one?*

Respondents felt that Jansen may have made it seem as a strategy to make C2005 visionary, the reality was there was thinking around implementation issues, it couldn't be divorced from the kind of work they were doing:

> *When you try to devise a fundamentally new curriculum you automatically you become uncomfortable, you know in the classroom talking about implementation so we had to think about it as well, you know there was definitely the realization that implementation was going to be hard and difficult and were we really on the right track in developing a curriculum, we weren't really sure, that was innovative and novel. In that case I will mostly say to myself well, if we want to change we have to really put a mark somewhere, surprisingly different from what is going on rather than say oh yeah new curriculum, I think its what everyone has been doing all along, it can be implemented, there's no change* (Policy writer D-C2005).

There was an acknowledgement that there was an intention to bring about change in the classroom but not much conceptualizing going into the change process and curriculum development resulting in a symbolic/visionary policy. There was also the feeling that the post apartheid government was under political pressure to ensure that change does take place. Teachers at ground level were left to pick up the pieces:

And what was really, really learned at ground level for teachers, how on earth are they going to get this whole approach which was very visionary, very vague, very new, completely devoid of a framework, how do you get people involved in the new curriculum. So I think the whole thing floundered at that point (Policy writer F-C2005).

Clearly, neither the teachers nor the various intermediate structures that were left to implement the policy were supported in the process:

You can't put a document out into circulation and assume that the policy is going to be automatically implemented. It needs a lot more work than that. And I think a lot of our policies fall into that category. They are basically sound, they have very good ideas, they have enormous potential but because they are not supported properly or they have an implementation plan on paper with dates without taking into account the human factor. (Policy writer C-C2005).

And there was a sense that you needed to dive in and muddy the water:

*My own view was that we needed a new curriculum, even if we were going to fail, we needed to dive into and make enough waves for people to realize that change is going to happen and change must happen. .... Being a very particular person was very worried about how teachers would handle it, and I think his concerns were absolutely correct. I mean, I thought there were enough agencies in the country to be able to bring about teacher change,....... The sense of my position now, I had somehow naively believed that we would have enough time to write the document that would be more teacher friendly and accessible than it actually was. Then, I blame the political process, where all Bhengu wanted to show parliament that he was doing something and pushed this thing along and promulgated a highly incomplete document (*Policy writer B-C2005).

6.2.4 Summary

This part of the chapter demonstrates that the rational model of curriculum development envisaged by the national Department of Education did not consider the contested terrain of policy development and that policy is essentially political. There was contestation at the macro and meso levels, which somehow resolved itself into the National Qualifications Framework (NQF), the critical outcomes, and OBE. In the management of the process, the process was weighed down by practical realities of coping with various interest groups in their effort to embody a broad stakeholder forum. The pace and nature of work did not allow stakeholders meaningful and full participation in the process. The policymaking process for the writing team in this period was characterised compressed time frames, inadequate conceptualisation of the curriculum design resulting in imprecise briefs, restriction of experience and a period of intellectual growth and enthusiasm for being part of constructing curriculum development history in a country undergoing transformation. The LAC meetings and workshops do not seem to have had impact on the product, nor did other 'science' stakeholders: it all operated between the writing team and the technical committee (see Chapter 7 on professionalisation as a regularity).

The outcome of this process was a key document spelling out the proposals for OBE and the weakly coupled C2005.The introduction of OBE as a curriculum policy was consummated in a dramatic public relations display in March 1997 when the Minister of Education officially launched C2005 in Cape Town. On this occasion it was announced that OBE would be introduced into Grade 1 and 7 classrooms in January 1998, a proposal subsequently limited to Grade 1 classrooms only. In the wake of this announcement, there was a flurry of activities as a series of popular documents hit the schools to explain OBE to teachers, followed by one-week information sessions (billed as 'training') for many Grade 1 teachers, as well as implementation in a selection of pilot schools in each of the nine provinces. Provincial offices were barely operating when they were tasked with the implementation of C2005. Newspaper articles carried features, supplements, critiques and review of the process.

Section 2

6.2 Development of the RNCS: A second go!

As many critics had warned, C2005 soon ran into a myriad of difficulties that threatened the survival of the new curriculum (Tema, 1997). Teachers complained of frustration, disillusionment, poor training provisions, the complexity of the language and design of the new curriculum, lack of support, and the general haste of implementation (Taylor & Vinjevold, 1999; Chisholm, 2000; Marnewick & Spreen, 1999; Jansen & Christie, 1999). At the beginning of 2000, when it became clear that the implementation of C2005 was not going well, the new Minister of Education, Professor Kader Asmal, ordered a review of the C2005. He was very clear that the underpinning OBE principles are not the subject of scrutiny. After a short 3-month process of reviewing various submissions and documents, and performing site visits and interviews with key role-players, the Chisholm Committee published its findings. It found that the implementation of C2005 was compromised by the complex structure (coherence and details were not clear) and design of the curriculum, tight time-frames, lack of resources, a weak model of teacher training, insufficient learning support materials and poor departmental support to teachers. (Chisholm, 2000: 27). The review team recommended that the C2005 be streamlined[3], phased out and 'strengthened' with a revised version in the form of a NCS. The proposed streamlining included reducing the number of Learning Areas from 8 to 6 and discarding some of the problematic designs of C2005 like range statements, performance indicators and phase organizers.

Furthermore it recommended that the terminology of the NCS (later termed the revised national curriculum statement-RNCS) should be accessible and clear and that a more flexible time-frame for implementation is scheduled (Department. of Education, 2001: 27). The review findings prompted the education ministry to task a MPC, with designing a NCS[4] within the context of the review recommendations. An important curriculum policy document was finally released at the end of July 2001, signaling the start of a second wave of curriculum change in South Africa. At the ministerial introduction of the NCS on the 31st July 2001, it was announced that although actual implementation will only commence in 2004, very important groundwork and pre-implementation activities would be conducted in 2002 and 2003. These include piloting of the NCS, teacher orientation and training and development of the learning programmes.

---

[3] It is interesting perhaps to look at why the choice for 'streamlining' and what the debates were: one the one hand, it was a way of making C2005 simpler to understand and use, but at the same time, it was a shift towards 'high knowledge' and greater prescription which can be seen as 'offering help' to teachers or as greater control/accountability. "Streamlining" is a word especially chosen – it suggests that there is no basic change to the OBE philosophy. But the introduction of Grade-based standards, and the reduction from 9 SOs to 3 LOs represents significant shifts. These debates were occurring at the macro and meso levels of policy development.

[4] The National Curriculum Statement (NCS) later (after the July 2001 inputs) became known as the Revised National Curriculum Statement (RNCS).

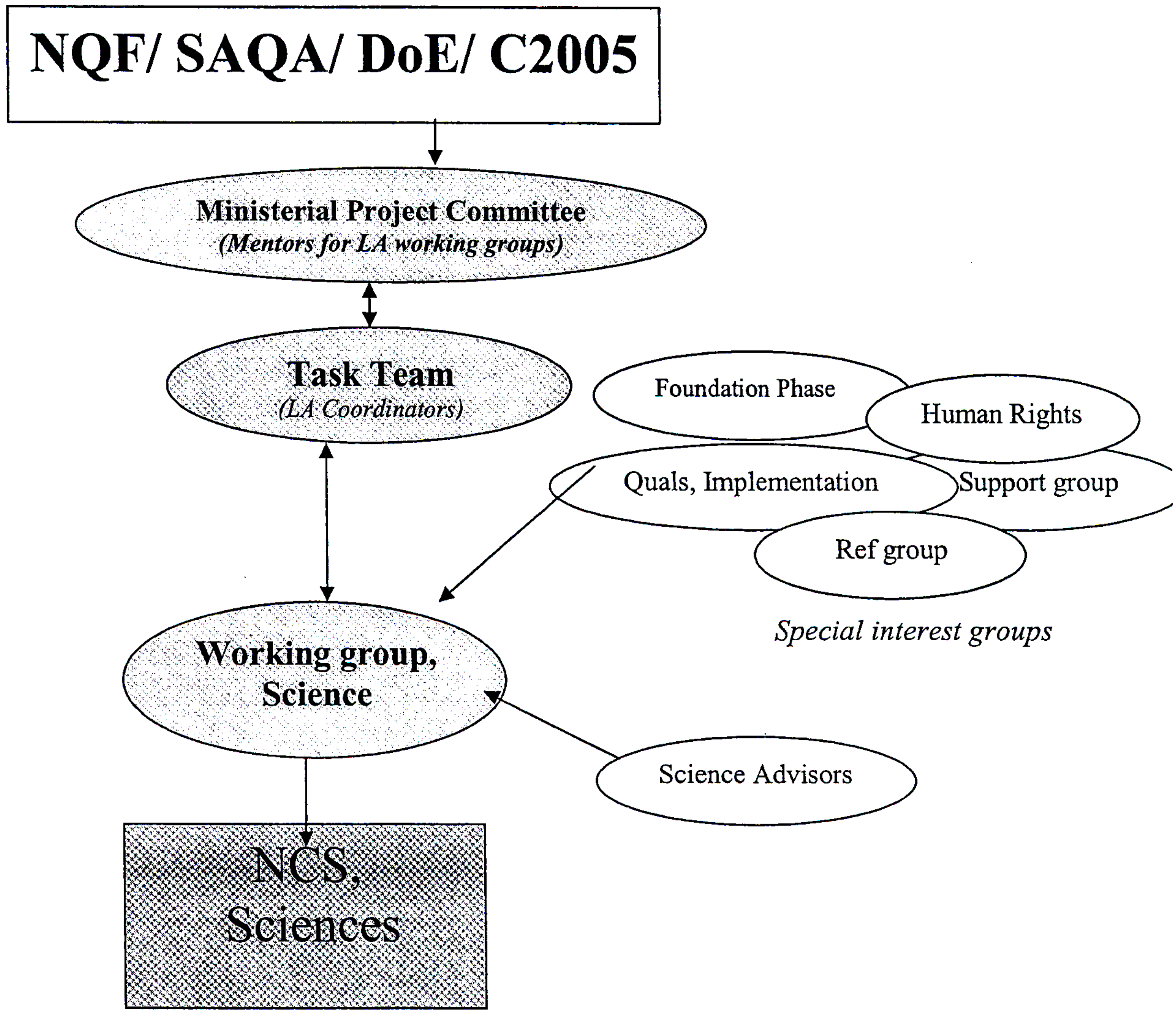
6.3.1 Who were the policy actors in development of the RNCS for Natural Science and why were they chosen?

The NCS process consisted of the Ministerial Project Committee (MPC); Task Team (made up of coordinators for each working group); working groups for each of the eight learning areas; groups to address particular issues i.e., for the foundation phase, human rights and inclusivity, qualifications and implementation; a support group and a large reference group. The eight Learning Area Statements was developed by a specific Working Group assigned to each Learning Area. The Foundation Phase Working Group developed three learning programmes and interacted with eight learning area Working Groups and the three transversal Working Groups (see chapter 4 for the constitution of these groups and a profile of the policy writers involved).

The rational choice for the working group was a small number of 'experts' working hard at streamlining the curriculum. The Natural Science Working Group had five appointed members and a chairperson who represented the working group at task team meetings involving chairs from all the working groups, members of the MPC as well as the foundation phase and transversal working group. Members of the MPC were attached to each of the working groups as mentors to the group. There were two mentors to the Natural Science Working Group. In December 2002, after the public input, four advisors were added to the Natural Science Working group. The management plan for the advisors was that each had to consult on particular content coverage and make special contributions. Policy writer J-RNCS was to consult on science in the Foundation Phase and make contributions to cognitive development and language in that phase; Policy writer L-RNCS had to contribute in the content area of life sciences and to examine implications for curriculum and teacher development; Policy writer O-RNCS in the content area of physical and earth sciences and to examine implications for curriculum and teacher development; and Policy writer K- RNCS to consult in the area of life sciences as well as to contact organizations dealing with environmental education, human rights and new research in indigenous knowledge.

Of the six members (including the chair) in the working group and the four advisors added to the group seven were males and two females. They brought in a range of expertise from professions like consultants, subject advisors and university lecturers. In Chapter 4, the profiles of four of the members of the working group, the four advisors and the two mentors are presented. Despite many attempts I was not able to get a response from two other members that were part of the working group. Appointments to the position were done through nominations, interviews and a formal appointment, unlike the C2005 process that comprised of interested individuals. Below is a schematic representation of the process:

The National Curriculum Statement: Expert Driven



Unlike the C2005 process the RNCS process has been characterized as expert driven. The 'experts' were selected through a formal process. Whereas the process of designing the first version of C2005 was representative in terms of stakeholder involvement, its revised version was representative in terms of individual expertise and experience; involvement of departments of education; race and gender participants; and stakeholder representation in the Reference Group.The number of individuals involved in conceptualizing and writing the document was also limited to ten. This process also included two mentors that were also part of the management team (MPC). Although the Department claims that this process was 'expert driven' Policy writer E- on the RNCS claims otherwise:

> *Well it was labeled by National as a..... C2005 was described as a stakeholder driven process while the NCS was described as an expert driven process. And I don't think either of those was really true. Last night we spoke about what happened in C2005 in the LAC and so there were stakeholders in name only. With the NCS, by July it could not be described as a stakeholder driven process at all. It was being driven by the task team meetings. Coordinators would present and it would be summarily critiqued. One document would be held up against another and strong advice would be given by people who were not experts in the learning area at all* (Policy writer E-on the RNCS).

The public comments were used to revise the draft Natural Sciences and Technology learning area statements. This involved adopting a more co-operative approach. The two working groups had common meetings – an approach that was totally different from the parallel approach adopted in the development of the draft statements. An additional member from the Foundation Phase working group who ensured that foundation phase issues were dealt with in the revision of the learning area statements, also strengthened the two working groups. This co-operative approach to curriculum design had the benefit of ensuring linkages, reducing overload and rephrasing the learning outcomes and their associated assessment standards to ensure compatibility and synergy between the two learning areas.

Policy writers forwarded the following reasons for being chosen to be part of the process: (i) those that were involved in the draft statements cited reasons of being nominated to the position, experience in science education and curriculum development, leadership and writing skills; (ii) Advisors to the group cited reasons of their critique to the draft statement as the main reason for being chosen to the group. There was also the reason of the smallness of the science education community and people are recognised for their work in INSET and curriculum development. Policy writer A- on the RNCS indicated that the advisors were chosen for their knowledge in OBE and C2005 as well as an understanding of issues on the ground; (iii) One policy writer felt that his appointment was by public mandate:

> *My being there was a public mandate, it was a mandate based on our constitution, every person has a right to a clean and healthy environment and because C2005 was an argument derived that the environment is a humans rights issue I came there and it was public and everybody knew that I am there to deal with the environment that is to find its place within the Natural Science Curriculum (*Policy writer K-RNCS).

In response to the item1 on the questionnaire on the policy making process (Part B) *Representation was based on expertise more than affiliations with particular groups*[5] (two 'always true, five 'often true' and one 'only sometimes true') it is evident that a small group of policy makers with expertise were chosen the second time round. Policy writer E feels that the group was based partly on expertise, partly on representation from department- these two are however not mutually exclusive. It is worth noting that Policy writers A and E were the only two individuals that were part of both the C2005 and the RNCS process. As mentioned earlier policy writers were formally appointed to the working groups. Policy writer E speaks about the kind of networking that went on at the time:

> *Yes, we were formally appointed, but to get onto the working group there was an advertisement in the newspaper inviting nominations of people to be on such working groups. That was in about Oct 1999 and I got a call from somebody who would actually have been ideal for the working group saying would I accept being nominated. So I said all right, I'm not sure what it is but put my name down. I contacted other people asking them if they'd like to be nominated and so in this way a network had already begun, starting of from the really public advertisement where anyone can nominate anyone else. It was right at the end of 1999. So how that list was put together, I do not know but I have no doubt that*

[5] This item in the questionnaire was by no means intending to suggest that expertise and representation were mutually exclusive.

*there was some strong debate behind the scenes before the list was finalized. That was not in the Natural Science Learning Area, that was in the Department of National Education, the MPC (*Policy writer E-on the RNCS*).*

There wasn't a deliberate attempt to exclude people that had been involved in the C2005 process- indeed their was a choice for continuity. Policy writer H-RNCS feels that bringing having many people on board would influence the process both positively and negatively:

Look, I think It's important. A large number of people find C2005 problematic. I think its important to bring on board new people but you also need people who were originally involved on site to find out what was their thinking when they were originally involved. But I think here, what has happened is the entire design had changed. From eight features it now has about four. That was one aspect and I think they were looking for people not being influenced by what they put in. What happens its like, I've been involved in this process, lets say there's another group that's going to come in, in ten years time to re-design this. I've obviously not going to feel good about this, if I'm left out of this process. You know it's something we have to accept, because sometimes when you do things, you find it hard to let go. So maybe it's a good thing that they had new people (Policy writer H-RNCS).

6.3.2 How did the policy problem emerge and what regularities made it possible for this problem to emerge?

In Chapter One, an account is given of the context of reform for the RNCS process. In Chapter 5, I explored what policy writers see as the policy problem. In this chapter I will explore how the policy problem became socially constructed. At the macro level these pressures are (amongst others), commodities and marketization, consumer confidence, economic problems (government debt etc), social problems (inequity, no infrastructure, fear of instability, health etc). At the meso- level of curriculum development the pressures to be identified (amongst others) are poor learner achievement, poor teacher training and development, portability, language of the curriculum, inequities in educational provision, inclusivity issues, poor development of learners intellectually (knowledge and skills), etc. At the micro (at the science curriculum development) level these pressures are hasty vision for curriculum devolution, lack of specification of content, poor state of science education, low pupil achievement, low skill development, etc. A guideline document called *The Road Map for the development of the NCS,* states that the streamlined and strengthened curriculum for the General Education phase for schools builds on the C2005 policy documents (DOE, 1997). In particular, the strengthened Curriculum 2005 adopts: (i) an outcomes-based approach to curriculum; (ii) the principles of progression, integration, relevance, access, redress and equity; (iii) the proposal for the development of a National Curriculum Statement. The recommendations of the Ministerial C2005 Review Committee on the design and structure of the NCS are adopted as the starting point for the development of the strengthened C2005. The NCS for schools in the GET band therefore 'should detail which knowledge and skills within each learning area, should be taught when, in what sequence and at which level of competence'. The C2005 Review Committee suggested the following four key design features for the NCS:

- Critical outcomes – the 12 Critical and Developmental Outcomes are retained and guide the overall development of the NCS
- Learning Area Statements – define the learning area and its essential features, that is, what is unique about the learning area and its role in producing the kind of learner required in the 21st Century.
- Learning Outcomes and Assessment Standards should:

➢ specify the sequence of core concepts, content and skills to be taught in each learning area at each grade level

➢ represent an integrated skill, concept and content statement of the learning outcome

➢ describe the expected level and range of performance for each learning outcome at each grade

In addition, the C2005 Review Committee report suggested that

- assessment exemplars should accompany the NCS. These would detail what kinds of tasks can be set, what assessment strategies adopted and the kinds of answers that can be expected.
- the learning outcomes should be designed down from the GET exit requirements.
- the learning outcomes and assessment standards should be seen as minimum or core knowledge, skills and values to be covered but should not be all that is taught. They indicate what is essential for progress through the system.

This section of the briefing document elaborates the frameworks to be adopted in the development of the National Curriculum Statement and indicates how these frameworks will be implemented through the development and design of the RNCS.

The lack of prescription in the C2005 document did not achieve the desired outcome of curriculum devolution:

> *Well, I think back to the actual process when the group actually started, the fact the 2005 framework was still really a lot of thin air and there was no prescription at all and what we tried to do was integrate the different themes because the way the group worked was that certain people approached the themes in different ways. So what I did earth and beyond and I looked around for curricula models, I looked at the Australian model, the New Zealand model and the British material and I looked at quite strongly the American, what happened in America curricula statements that they had there. So really it came from trying to see what can we.., we've become kind of conventional around these kinds of process, you know look into those frameworks and look at how we can weave it into what we are trying to do here. But I think behind this is primarily between the American version and the Australians, I found the New Zealand one a bit different and then, ja we tried to make something for ourselves. It was kind of accepted by everybody that it really had to change but there were those leaders in the 2005 area that were being entirely unhelpful in giving direction in what should be in terms of it being strangely anti-content. No one was under any other view than it had to be quite extensively reworked* (Policy writer I-RNCS)

The reworking of C2005 policy documents was a consequence of recommendations by the Review Committee published in the Chisholm Review. The C2005 Review Report (2000) states that C2005 is 'overcrowded' by design features and inputs are underspecified. As a result

> *there is real chance that teachers will miss out on key content ... which places the acquisition of higher level skills at risk especially in the 'gateway' learning areas. ... When the under-specification of content is coupled with poor subject content knowledge and a policy that minimises the role of textbooks, then a great many teachers have no way of knowing when key content and concepts are bypassed*" (C2005 Review Report, 2000: 47-48).

Policy writer N-RNCS and policy writer E-on the RNCS, comments on the pressure from people on the ground, and other projects going on at the time, conducting evaluative projects on the implementation of C2005:

You know, right from the very beginning we indicated that what was in the policy documents would not work. Its not practical for various reasons but of course the National Department of Education (NDOE) did not listen to us and they went ahead anyway so what was recorded by the RC was in fact the pressures from teachers largely and the parent community also made noises but I am not sure on what basis the parents comments were made. I suspect it was what they had heard from teachers and the media. So the pressures came from teachers and the parent community but I am not quite certain about the parent community. The parent community reacted from teachers and the media and that sort of thing. (Policy writer N-RNCS)

and

I think the Review process report that was published on the 31 May 2000, the fact that it happened at all, the fact that the Review Committee was appointed, they were *appointed towards the end of 1999 which left them two years into the implementation programme, that in itself tells you there was a lot of pressure, coming from people that were alarmed at what was happening. So the report that came out was obviously a compromise document as these things always are. But I think it reflected those concerns. There were evaluations being done of the training programme and what was happening in the schools. I think one of the major influence was the JETS report: Getting Learning Right, by Nick Taylor and Penny Vinjevold, a report by the President's Education Initiative research project and it was published by JET itself and they were basically saying that schools were not able to cope and from JET there was quite a strong feeling that C2005 had lost touch with reality and there were comments like this was a complete waste of time, what was needed was a simpler, clearer syllabus, more of teacher training and better monitoring of schools. It said that teachers were not teaching and that low standards were becoming acceptable. So, yes that fed into the Review process and those were the major pressures* (Policy writer E-on the RNCS).

Policy writer A-on the RNCS from a management perspective comments on the politics of curriculum reform and the legitimization of the government agency:

> *The new leadership comes in, the first one that was approved by the Council of Education Ministers, it had only four design features. It had critical outcomes, specific outcomes, assessment criteria and range statement and before that performance indicators, sorry five. So the new leadership comes in, there's pressure on the ground, they say look but the Review report says there's under-specification. There's pressure on the ground for more specification.* (policy writer A-on the RNCS).

Policy writer I-RNCS speaks eloquently and strongly about science conservatism, especially in its epistemology. He claims that the changes made were merely dressed in the 'right language':

I think science is an exceptionally bad case of it. There was no tendency to change. I think basically there were very little changes especially in terms of ideology. If you take geography, you don't have to be there, but I think geography will say that if you take the kind of shifts towards a more social geography approach. Geography was also looking exceptionally old and tatty, but I think science was in a really bad shape because science is a way of conserving, science is a very conserving enterprise anyway. So there are contesting forces that are very strong and there I will care to advance it although in the FET, found that in the key documents there was all this nice stuff from the GET. When it comes to the content there will probably be very little change. Its now being dolled up in the right kind of speak but I mean not to underestimate how conservative in the knowledge science is (Policy writer I-RNCS).

At the ideological level, there were issues that were not coming through in C2005 as is reflected by policy writer N-C2005:

You see in C2005 there were issues such as human rights issues, social transformation issues, indigenous knowledge, environmental issues, but it did not come through very clearly. That part it was upfront and there was quite a lot of debate and discussion and papers presented at National level at the Ministerial Project Committee (MPC) about human rights, about social justice issues, about social transformation, about animal rights issues, that's going to come out quite clearly in the curriculum and about indigenous knowledge and so on and so forth. So in other words it was upfront in the debate, not only for science but for all other learning areas.

These issues were deemed important by government agents to achieve social transformation. They were issues that were recurring and consistently emphasized. This last section clearly indicates that the pressure for a more conservative curriculum, with a stronger emphasis on discipline-based content (high knowledge)- yet working within a social justice framework was clearly something the writers were struggling with.

6.3.3 Shaping Policy Choices: What happens in the policy environment that led to choices made?

Rules or Regularities: Constraining/ Enabling?

Policy writers were asked to comment on the strengths and weaknesses of the way in which the policymaking process was structured as was done for those that were involved in the C2005 process. The focus/point of entry is on the personal contributions, struggles and experiences of a range of individuals in the course of developing curriculum policy within a structural framework and the relationship between the science team and the MPC. Policy makers attributed **weaknesses** to the process because of the following factors:

a) Responding to political drive rather than pedagogical needs

The intention of management was to put together a team of experts from across the field with the intention of writing and supporting the writing. There was a need by individual policy makers to consult others in the field and policy makers felt that the management made decisions about who would be consulted to the detriment of the actual process as is evident in

> *The curriculum is driven by politics in this country which is purely ironic the extent to which as curriculum has been politically driven under apartheid..... Its so strange that the curriculum manifests itself in the same kind of political, eh trying to respond to political needs in terms of what it produces..... we were not allowed to consult with people and I think that went away a lot in the next stage in the rewrite where there was a clear image that the process was so faulty* (Policy writer I-RNCS)

Also there was a political tension between Departmental and non -departmental people in ensuring that the document produced falls in the right hands:

> *there was tremendous tension in terms of .... Instead of looking at what's coming out in openness I think the MPC members found the need to defend the document, the learning areas for which they were mentors. It was a point scoring exercise I think. You were the mentor for the science and you guys didn't do your job and that tension was there and there was also tension because we wanted to extend the learning area and there was also another huge tension as I had indicated..... There were tensions between the DOE people and the non departmental people and I think part of the tension arose because of the way in which the RC's recommendation was handled. The way the report was handled....... It was made quite clear that what we were producing was to be handed over to the DOE, that there mustn't be a repeat and that the DOE will release the document.* (Policy writer N-RNCS)

b) A Case of Professional Abuse with Imprecise Briefs and Working within Political Parameters

Policy writers E, L and J-RNCS comment on the tensions between people in management positions, that infiltrated down to the working groups in the form of imprecise briefs:

> *It was an extremely bad one (the process). It amounted to a form of professional abuse because the brief had not been thought through. I am not saying the people couldn't think or didn't think, just that they hadn't taken long enough to reach a consensus in order to produce an example. It was almost as though the working group were being asked to produce examples and the project management will then make a selection of what they preferred. In many cases the working group were never able to succeed in the task. I think the key challenge was that we never knew what it was that was wanted and we began to suspect that the project management didn't know what they wanted either. So I mean there was no consensus on the project management on what is wanted and they weren't producing any useful examples for us. I mean they were giving us examples but they were really trivial. So in the writing up to April 2001, which was obviously the July document the challenge really was dealing with the brief in the task team meetings: that content should not appear in the document, and we were aware that content had to appear and so it became a matter of trying to second guess the task team and deal with the content in some way that gave the reader some indication of what's to be learnt and taught. We didn't have a lot of problems on settling on the three learning outcomes, the wording changed all the time. The real problem was that we were increasingly coerced to conveying the content in the assessment standard for each level. We probably restarted the document. I don't mean edited the draft, but we went back to the drawing board three times and in the end we just gave up and produced the document of July 2001, which reservedly was heavily criticized and I think that most of us felt almost vindicated by the criticism that poured in. .... The brief from the MPC, it was issued very strongly. We were told in no uncertain terms that this is what we were to do, but there was considerable lack of clarity in what it meant. I think part of it was the working group had to spell out grade by grade the sequence of skills and concepts to be learned. And then we had to write assessment criteria having the three learning outcomes (LO), assessment criteria per learning outcome. We spent the first meeting of three days and the next working group meeting, people had come from all over the country for that, trying to work out what the brief meant and in fact there was never clarity on what the brief meant. I think you can infer from that there was no consensus behind the scenes on what the brief should be and if you look at the make up of the MPC and if you look at the history of the individuals and their commitment of each person would be prior to that, you can understand why there probably had not been consensus. So the writing process that led up to July 2001 version was an extremely fraught one in the sense that the brief was unclear, the pressure was high, the deadlines were tight, the working groups did not have time to talk through the philosophical issues. There was this pressure to deliver in a technical sense. And during the writing process the fact that the brief kept changing*

because the process involved working groups getting together at hotels in various parts of the country producing a draft. Then the coordinator of each group would go to Pretoria. The task teams consisted of the coordinators of the working group from each learning area and the MPC. The coordinator had to present the draft in half an hour, an hour maybe and the entire rest of the group with then critique this. The coordinators presentation was also scored on a grid looking at a number of factors, clarity of outcomes and so on. Now what this meant was that the people that were critiquing were looking at the draft for the first time. There was no time to reflect on what it meant but judgment was going to be passed in half an hour. With the judgment and the grid completed by the members there, which was then tallied and that served as an evaluation. And the coordinator was sent back to the working group with a brief to rewrite in a particular way, which came back to the working group, that was like building on shifting sands. Not only was the brief unclear but from month to month things were changing and were unclear. The document from one learning area would be approved as a model to be followed and a month later it was no longer in favour and another one was approved. (Policy writer E-on the RNCS)

And

I think one of the weaknesses which was rather disturbing was the way instructions changed from one day to the next. We would meet and be addressed by the MPC or the DDG or in the case of the learning programes by ....and there would be certain instructions. Obviously trying to convey something that they got from higher up. Then when you started to work on it you then found that they didn't get it right and you had to revise what you had put a lot of effort into actually because its not really what they wanted. I'd give you an example. When we were about to come out with the document the instruction was we needed a one page overview of what the science was, what we were trying to do because there was a sort of review that was going to be presented at cabinet and so we stopped everything that we were doing. We then maybe realized that we should not all work on this, the chapter.......one will work on it and actually tear that apart and actually see to it that it produced and we did that and I was assigned a major portion of that. I produced a one pager which was not very different from what was already there, it was condensing it to one page which I think was needed. It was a lot of work and it looked like the group felt like hey after changing it here and there it was very South African, it was about science, it was what we believe about science and we had a deadline and we submitted it before the deadline. Just when we were actually submitting it the instruction came, no actually what is there in the document shouldn't change. Now we were battling with so much work and I think in the end we insisted that one of the paragraphs that was in that one pager goes into the document because we felt strongly about it , were talking about something new. You would get things like that were you sort of got instructions that did not make sense (Policy writer L-RNCS)

And re-iterated by policy writer J-RNCS

I think one of the difficulties, the MPC itself had neither uniformity nor clarity of vision and I think that was a problem, I mean there were different elements in the MPC who had different ideas about how things should be done and there was also an uneasiness in the

MPC of strength as mentors. I mean those are personality things and cannot be avoided, some people are better mentors naturally than other. Some people understood the process better. And I think that people in the working group expected that somebody, somewhere had the right answer. You know you kind of did something and got quite taken aback when people said oh but that's not what we want. You say but that was the brief but no a lot of that kind of discussion and I think there were some uncomfortable moments but I think its those kinds of drawbacks that's always uncomfortable (Policy writer J-RNCS.)

On the issue of briefs, policy writer H-RNCS, recognizes a particular value of going through the process set by the MPC:

With the new process we had learning outcome and assessment. The MPC themselves didn't really know what they really wanted, those definitions and terms that they gave to us right at the beginning, we started to work with the development of the curriculum, we used those definition and found that we were ending up with a kind of syllabus. That's the importance of the structure they had the MPC and task team. Task teams delivered their presentations, it was important that they had that because people, co-ordinators from the different learning areas were doing their presentations and one of the things that came up was that there was conflict with regards to the understanding of those definitions. They went back to the drawing board and had to edit those definitions (Policy writer N-RNCS).

Policy writer K speaks of the intellectual capital of the mentors working within a restricted structural framework:

In other words the structure was built around making sure that we adhered to the decisions made by the MPC based on the policy guidelines, the broad policy guidelines……The idea, each and every individual on the MPC came there with there own intellectual capital that lent to one side or the other different meanings, then they would say something which would come back from the MPC, you can see who were the strong people on the MPC. It was just a human construction. So for me 1) this process was in place to make decisions out there staying within the parameters of the broad policy in there you could see the social construction of knowledge, you know playing itself out. I must say that I was only part of this from December 2001 and it was a very, very tiresome process but I was very lucky that ………was our chairperson and he allowed very importantly everybody's voice to be heard. That's the one thing and secondly under no circumstances did one get to feel that dominated because of the way he chaired our sessions. But something we were lucky about we worked together as a group. *Often you get a really obnoxious guy that can make the experience really bad as far as the NS is concerned I must say our group really worked together as a team.*

This difficulty was real: on the one hand, the team was looking to the MPC for clear guidance, and on the other hand the MPC was looking to the various writing teams for this guidance. It is not so much a failure of concept (of the process), but failures in making the iterative process work. There should possibly have been workshop early in the process, whereby the brief was settled, with input from all the teams and the MPC. But gleaning from the responses of policy writers the brief was constantly changing. The mentors from the MPC only talked to teams individually placing the MPC in a strong but vulnerable position, so contestation within the MPC must have been enormous. What was also interesting is that the NCS writing team expected- almost wanted the 2001[6] version of the NCS to be soundly criticized, so that their complaints about the MPC would be validated and the team would have another chance:

> *I think we have given enough of the picture to locate that 30%. The criticism of the July 2001 document was mainly in the case of Natural Science, more so than the other learning areas. Even before December we knew what kind of criticism was coming in. It was so severe that I think the MPC almost acted out and said you try and do it, you try and address the criticism. So it was an opportunity to take the criticisms and say, now this is an opportunity to write what we wanted to write a year ago* (Policy writer E- on the RNCS).

c) *Time Constraints*

Not unlike the C2005 process policy makers also speak about the haste of the process:

> *I think the main weakness was the haste in which it had to be done. That precluded getting input from a wider group than we did. We always said that people need to be involved and if you look at the documents that were developed elsewhere, if you look at the United States document it involved at least two hundred people working something like a period of four years and there would be reworked and go through several processes, where in fact the very severe deadlines and it was a rushed job. I don't think it's an ideal document but I think it at least its not a document like the first ....I think it was mostly time, and also there were these particular guidelines in the documents that had to go out immediately for approval and at that stage the chairman might be given some feedback to bring it back and then it would be too late to discuss in the committee because it had to be printed by Friday or something. And so opportunity to deliberate over it between the different levels who were responsible in putting the document together I think was quite problematic* (Policy writer)-RNCS).

[6] The 2001 version of the NCS is the set of statements released in July 2001 for public comment.

And

The conflicts were one of time. How on earth do we do this and do I feel committed to this process. I simply feel abused in this process. Do I want to continue writing? (Policy writer E-on the RNCS).

d) The nature of the Critique

Draft documents and written discussion pieces were presented at task team meetings to be critiqued. It was a test of your professional abilities as is evident in:

> *The thing I found overwhelming is when you had to present things and the critique was gosh the people did not mince their words, if you did not know what you were saying you got thrashed from a dizzy height, you know and they were not kind, I everybody was in the same boat anyway to make sense of it anyway……………..As I said I don't know how else they could have done it…… You know the MPC kept saying you know don't take the criticism personally, but when you have been working on something, all day all night for three weeks, seven days a week till everything else in between your own jobs and somebody comes up and says this is a bit of rubbish. How can you not take those things personally. You know, because you go away, you got an idea in your head, then you come back and you pith your ideas in front of all these people and they look at you in amazement and say: what? what?, you know, its very hard not to. I mean I don't think that people were trying personally to be vindictive, there were a lot of sensitive moments and I think public comment helped because it took it away from you. You know it wasn't directed at people, it was directed at each strands rather than you* (Policy writer J-RNCS).

e) Practical Stresses

Policy makers came from far and wide. It was sometimes a mammoth task to try and get everyone at the same place at the same time to attend working group sessions. Policy writer E on the RNCS speaks about the practical stresses in the science group:

> *One member of the team had his Phd and had many years in township schools, he was being employed at post level one and with that he was not released by his department in order to participate. Another suffered from a complete lack of interest from his department. One of the effects was it took him hours and hours of travel to the meetings and sort of five hours by road and waiting around and couple hours by air* (Policy writer E-on the RNCS).

Policy writers attributed the **strength** of the process to the following:

a) A common design for comparatability

To develop a National Curriculum Statement had to have common bases to compare with in the different learning areas, yet the process did not account for the unique needs of the learning area as evident by what policy writer N-RNCS says:

> *So it helps to make certain that there is a certain degree of uniformity in the design but it has a negative impact in the sense that you don't have people at the top that understand clearly the different learning areas have their own different needs you can end up with a problem where you are going to force a learning area working group to fit into this. This is what we were asked to do. We were always right, seen as the rebels. We were seen as the people who didn't follow the brief, right, or wouldn't follow the brief* (Policy writer N-RNCS).

b) A Determined Effort to address public Input

The first draft of the NCS was released in July 2001. Unlike C2005 there were relevant structures in place to respond to the input. Policy writer L-RNCS sees this as one of the plusses to the process:

> *one of the plusses I was happy about was the seriousness with which each comment was taken, I also wrote after the first draft, I don't know whether it was the reason why I was invited but I was really impressed with the way, there was a real effort to try and operationalize what people had said* (Policy writer L-RNCS).

And policy writer J-RNCS speaks about its usefulness in depersonalizing the process so that the content of the public input and not the presenters became the object of critique:

> *Those things were helpful, but it's a kind of torture, you know you went round and round until you got it right and okay, this is exactly what we want now were do we find it? And I think what was helpful was the public comment because what it did was, it depersonalized the process* (Policy writer J-RNCS).

c) *An attempt at streamlining the curriculum and not re-inventing the wheel*

Coming out of the review committee recommendations the brief of the MPC was to strengthen and streamline the curriculum, not a drastic overhaul. Policy writers see this as a strength of the MPC in carrying out this brief:

I think one of the jobs that the MPC did really well, I think we were continually being cautioned that we were not drafting a new curriculum. And that you needed to look critically at the first version of C2005. And streamline and strengthen it and I think they kept hammering this point that the SOs had to be retained. Were things were not working, or not practicable or not usable, they could be changed. You shouldn't change things because we felt like changing them or we felt that our ideas were better than the original. I really, really think that people have engaged with it and I don't know whether the general public knew just how hard a job it was. (Policy writer J RNCS).

And

so there was one or two in the working group who were adamant that we were not going to reinvent the wheel, we should try and make the wheel progress and so on, to move on, they had no intention of starting from scratch. (Policy writer I-RNCS)

d) Getting it right at this moment in time

Policy writers were posed with the choice of having a curriculum institute developing the curriculum or as the alternative the RNCS process as it stood. There was a sense by one policy maker that given South Africa's history this was the right thing to do:

I think that's what I just said, when you look at the challenges of having such a big group, I mean I don't know of any country that has done it in that way and I think the input of the public was very important, I think that those groups have been very important. I think through the process, I don't think, I know though the process, the government officials who were involved were teachers or whatever, a lot of people and have moved into positions in government as a result of their contributions to the process and I think that has been a healthy development, that those people were given an opportunity to meet people of all works of like, different kinds of academia which they would not have the opportunity to do otherwise, so I think in a sense bringing all the people together from so many different places representing the entire country. It was a very important thing to do at that point in time. And that process, I know its cumbersome but it was overwhelming and exciting but I don't know how else we could have done it. I think it contributed to the acceptance of the curriculum, because although there were negative comments, nobody said it should be thrown out altogether, you know what I am saying. People contributed in a spirit of contributing, not to be difficult, I don't think you would have got that kind of commenting had you got a curriculum institute doing it. And

I think the curriculum is the richer for it. I mean it may be flawed because of that as well. I mean there is still to me some learning areas assessment standards are terrible. Because I don't think they listened enough to the public comment (Policy writer J-RNCS)

However policy writer I- RNCS felt otherwise:

The whole process, the idea of writing curriculum with one full time and a whole lot of people coming together every couple of weeks is absurd. The process was absurd. You know I feel you pump millions and millions of dollars and pounds into processes which take years and you have groups of people who are highly skilled, highly experienced in the area that they work and in this country you get people and you tell them you know you got less than six months to write this. It was absurd. It was an absurdity. And I think it reflected that. It was promulgated quite well in the second draft and its probably got away with it. It was an absurdity to try and believe that one could actually get down to it and deliver a product which was very and I don't mind saying it, you know if it wasn't for …… you wouldn't have a draft at all. He was one individual who took it upon himself to devote a helluva lot of time to make it work. That's normally what happens in a situation. You find individuals come together for, we weren't recognized for that but people involved know, which I don't feel too good about, it was a complete embarrassment in a way (Policy writer I- RNCS).

What were the conditions that regulated patterns of interaction of those involved?

In addition to imposed frameworks by government agents and the merits/ de-merits of that, policy writers were asked to comment on frameworks within the writing team itself that constrained or enabled policy choices. In response to item 2 of the questionnaire on the policy making process (Part B) : *the process of consultation was democratic* (two of the respondents had indicated 'always true', three 'often true' and two 'only sometimes true') and item 11: The allocation of tasks was as a result of collective decision- making(with four respondents indicating ' always true' and four 'only sometimes true') indicates that although there was a process of consultation, discussion and finally coming to a consensus, there was also a sense that the process was not as democratic as it would appear. The working group was characterized by a lack of conflict which policy writer E- on the RNCS acknowledges is not always a good thing:

……..and you know sometimes that's not always a good thing. Sometimes one needs some healthy robust debates, you know committing themselves to positions. Jonathan Clark was one member of the group who said you know, this group has no ultra male, referring to wolf pack. We never actually had any fights; some of the other working

groups there was always blood on the walls, but it never happened in the Natural Science. I think that's the style of chairing. I think the overriding concern this process had to be over in about four months, we didn't know what the brief was, we didn't know whether it was worth caring what the brief was anymore because whatever we wrote was tossed back to us and so there was a sense to get up there and say this is what I believe and what I will fight for in this group. (Policy writer E-on the RNCS)

And

In that group we were able to function like that, there weren't any strong voices which needed to be heard all the time. So it was very quickly decided, you know there wasn't a stretch of a line of themes, there were only four themes so four us could take a theme and …… …..a more coordinating role(Policy writer I-RNCS).

All members were not in one particular venue when issues were raised and discussed. Because of time constraints work had to be done outside the working group and brought to a common meeting of the working group:

*Obviously there were personal tensions. Obviously people came up very strong. …….. and so on had brought very much the science curriculum into the debate and that was great, it was open and it was discussed and things like that. And also whenever people wrote they would turn it over to..... and ………. and they would put it together and they would e-mail it back to us and we had the right to critique and so on. And when we come together those issues are raised (*Policy writer K-RNCS*)*

And

…….But the other small tension which would have been big if one did not address that which I found was that people in the group did not have equal amount of time. I had to take leave to actually attend the sessions. Some people were not in the same kind of position so they had more time to work on the documents. What I found frustrating, it was frustrating for me but I could also understand that we would discuss something on a Friday after four days and then when we were sort out palming out work you would say you do this, you do this, all the comments that were put in we sort of combine them and because some people had more time to interact with the documents, some of the things would not fall into place and there would be try and drop them, that meant that there was no chance to talk to and challenge but we decided we were going to put this thing and so on then they got to start afresh and explain to us the reasoning behind, sometimes it would be accepted, sometimes it wouldn't be, *some people with, because of the proximity …… is from Durban, we could do lots of things just by phoning because……close to each other. …………and ……… because they had worked together before, they would have more time to talk about things and …….. in the Northern Province would be on his own. And also the lady from …………, you will find that each time we met we would have to do a lot of catch up and what had developed in our thinking and so on. When it happens to you when you talk to them its very natural and you are changing your direction you forget that you are in Cape Town and……………, although he was in Durban he was kind of busy and so he couldn't attend everything. And ……had lot of time he was also the co-ordinator and because as the co-ordinator*

he was accountable he was also trying to make sure that the deadlines are met which meant that he had to actually put more than the rest of us. And also the responsibility was ours actually also, we would do things and e-mail and say here's what I have done, if I don't get a comment by a certain time I would take it as accepted. But then there's always people who... people like .... who maybe I can call it an agenda, maybe it was a commitment to the environmental side of things. That was helpful in the sense that he didn't, or wouldn't allow us to ignore that or forget it (Policy writer L-RNCS).

It was left to the individual's personal commitment to the process to ensure that issues were commented on in time before the writing. Policy writer A adds:

> *considering the nature of tasks, the working group took responsibility for writing different aspects of the draft so there was a distributed workload and a shared responsibility* (Policy writer A-RNCS).

And policy writer L-RNCS speaks about his role of advisor for a particular task did not turn out as anticipated:

> *......Well that was the plan when I got in but because of the way we were dishing out work and so on we realized there were gaps and so on, a lot of the assignments I got were not strictly life and living and so on. Some of them were to polish up on the overview statement which was the introductory statement, some of them had to critically look at the defections that other people had worked on and so on and sort of got entangled in a way (*Policy writer L-RNCS)

In response to item 4: *Some members of the team dominated the discussion and strongly influenced what was put into the final policy* (two 'often true', one 'only sometimes true', two 'not true' and three 'definitely not true'), policy writers responses were characterized by a distinct lack of conflict:

I think again within the group those of us who would suggest and have some experience and understanding of the debates that goes on in that area. There was consciousness all the time that we were aware ....It was something which we would talk about. But we had agreed upon quite early that there were key concepts in science that we wanted to weave in and they were to fit into a logical progression and again there was enough of examples and models of where people were themselves. If one had to do a similar kind of thing here...but you see we weren't reinventing the wheel.....But the debates, in science there is a fair amount of agreement about the big ideas, the ideas to be taught. I think what we had to work through there was a problem was ...the absurdity, I think that's the nicest way of putting it of what was coming out in our new framework about skills in isolation. And so we had to kind of work through getting over some of what I thought was real teething problems when it came to already on the table which was a skills learning approach what is was all about, the whole learning approach, you know *learning skills, learning by enquiry to grab on, you know science by inquiry, we were trying to encourage science by enquiry, that was a very strong element. None of us would disagree with that at all, we would all prescribe to that view. We didn't actually have time to argue a lot the conceptual issues we were trying to get a handle on what we were supposed to be doing, there wasn't conflict like that in the group at all. We didn't think about things like that* (Policy writer I-RNCS).

This is consistent with the responses to item 8: *Some members of the team had vested interest in channeling the discussion around certain values* (one 'always true', two ' often true' one 'only sometimes true', two 'not true' and two definitely not true') and item 12: *Compromises of competing interests and demands reduced the integrity of the final document* (two 'often true', three 'not true' and three 'definitely not true'). Those thatresponded 'often true' to the item speak about the compromises in trying to bring the technology and thenatural science working together, looking at the assessment standards in the intermediate phase, its heavily weighted towards technology.

More than C2005, there appeared to be a concern for implementation issues. In response to item 5: *Much of the discussion revolved around implementation issues and what needs to be done to lay the foundation for implementation* (one ' always true', three 'often true' two 'not true' and two 'definitely not true'). The working group were briefed that there would be a special group that would discuss implementation issues. Policy writer A-on the RNCS acknowledges that there were concerns and not discussions on implementation issues. Policy writer H-RNCS concurs:

> *There are two issues here. One is that policy is developed with the assumption that teachers are qualified. As we were developing this policy, we were putting things on another paper for the implementation group. There were a lot of things we put down. We would say.... This will only happen if teacher development takes place, a greater deal of teacher development. We had a number of things like that. So for the majority of teachers that was the case. They need a document where the curriculum can be successfully implemented. But it must also take into account that many of them will not be able to read the policy and determine the content and so on* (Policy writer H-RNCS).

Policy writer I-RNCS speaks about the vast experience of practice by individuals that were involved in the process, yet policy has not been informed by practice:

If you look at people like …………, he has a lot of experience in practice. He had a lot of experience, and he said hang on one has to try, to tie it in I'd say once again ….they had no idea, it was so rhetorical, that's what they are, they are rhetorical statements, they are rhetorical documents. I think it's a document of intent, but whether that intent is ever realized in practice is of course our context, which is a multiplicity of contexts, just trying to start we somehow believed that we have a policy involved there's practice and the deep disappointment that doesn't materialise, that is really what's happening now, I mean coming out of a particular curriculum, I mean everything is dropping because of timing…If you look back at some of these statements you can see how these issues….and I'm not convinced, on one level I'm not convinced that a particular statement may allow people who somehow have an effect on practice. You know you are given a framework to do that but whether it will bring about systemic change, I'm doubtful. It doesn't work like that in the real world of the classroom. But its needed and I understand on the curriculum level you need a policy and it's a nice policy framework but whether that influences practice I would argue its again, it refuses to take reality as the starting point. If you understand the reality of the classroom, the reality of the post apartheid education system, that's the product of apartheid. We reap what we sow you know, and we were sowing in our past in terms of apartheid. You can't wish it away, you can't make it a new crop and pretend another crop is growing there when it is not. So given the idea of curriculum approach that we don't ……I would much rather the starting would be watching what works and what doesn't (Policy writer I-RNCS).

Other policy writers agree that this was a wide, open policy statement with very little practical guidance given to teachers when it came to implementation:

We fell into the trap in our drafting of going the exact opposite of making it impracticable. That was the MPC's directive, the MPC's directive was to make it grade by grade, high skills, high knowledge, it had to be high skill, high knowledge grade by grade. We had to specify the skills and content with due regard to contextual progression and integration. We resisted it by the way. We resisted it. We stuck out like a sore thumb because we said the moment you tie up your content with your outcomes or assessment standards then you would have simple bits like the old style objectives, very fragmented and you'll need to have a multitude because now you have to cater for every eventuality. I would end up with a volume and also it would no longer be education because it would prime the learners in each of these things and if you don't do work it becomes reductive. It's kind of the old syllabus kind of thing. So that was the brief by the way, our brief was not to keep the skills, the assessment standards different from our content area. We resisted that and we got flack from the MPC, so we had to go the route of the other learning areas in particular……… They were very prescriptive and we were not happy about this. So we went from what Jonathan Jansen had said that it was a policy statement which was good in itself but which was not implementable, to one that was implementable to the extreme with no degree of flexibility for good teaching and nothing that took into consideration that were different contextual factors. Lets put it this way, had we been working with all qualified teachers that document would be sufficient. So we are catering for the fact that there are teachers at different levels. That's our intention.

So eventually that learning programme policy guidelines will be unnecessary, that's the stage we will get to in five, ten years time but in the interim, its absolutely necessary (Policy writer N-RNCS).

Much would depend on the implementation guideline document and what is available in terms of published materials available at schools rather than the policy document itself, as is evident by:

That is not so unusual or surprising, one of our working group members, one of the advisors who joined us had just been on a tour of the UK and he came back and he was actually surprised at the very sophisticated education system. When a teacher took over a class when he came into a school, he didn't look around for the policy document, he looked around for published curriculum materials. He looked around for published courses and he would sit down and browse around and make their selection from that. So on the one hand its important to say that teachers can interpret the policy document on the other hand its important not to live by that expectation. People may read the policy guidelines and have certain expectations and ideals, for INSET, people that develop assessment and certainly for the commercial publishers. Some of them go around and find the very best people they can to write and interpret the document and that overwhelmingly in all education systems. That is the way the curriculum gets to schools. (Policy writer E-on the RNCS).

There was an awareness that implementing the policy was going to be difficult:

Well I think the indication is the realization that the policy we were putting together was to be very idealistic and to clearly implement the science as the policy was going to be difficult. The policy could sit for 10, 20 years and everybody at that stage could jump over it. It does not provide for continued improvement and that then ....So yes the bar has been set very high with the expectation that the implementation is going to be realistic and the people are going to be helped to achieve basically a very high standard with the science curriculum (Policy writer O-RNCS).

Policy writers were asked to respond to the statement made by Jonathan Jansen in his book: 'Implementing Education Policies' that policies (C2005 being one of them) produced in the 1994-1997 period were highly sophisticated and merely symbolic or visionary rather than being intended to bring about any fundamental change in classrooms? Policy writer O-RNCS acknowledges that the criticism had been a bit harsh:

What I can agree with him is that there is not nearly enough emphasis placed on *implementation issues making the policy itself un-implementable. So I think implementation is being neglected. I am not sure what I see Jonathan saying deliberately and frankly I think it was done more as something to say than trying to bring a halt to the whole education. So I don't think that Jonathan takes on this stance deliberately but I do agree implementation has been under-emphasised (Policy writer O-RNCS).*

And policy writer L-RNCS agrees that policy is more than a symbolic gesture:

I wouldn't agree with the statement as it stands. I think that to me the policy written is much more than a symbolic gesture it is an intention to change. I don't think policy...I mean change cannot be legislated. I think I have been involved in science and certain programmes for a long time to know that the difficult part is implementation, but I wouldn't say that because implementation id difficult people who come up with policy are just doing it as a window dressing kind of thing, there is an intention its just that when it comes to the implementation people have got to realize that from policy to implementation there is a lot that got to be done to support that change, you know somebody once said that I don't consider implementation but when you bring change this is my experience, its very difficult but when you bring in change especially when you are trying to bring in change in the classroom there is a percentage maybe 15 or 20% of teachers who will jump at it because they are always trying to do something better,……… Then there is a big group that need encouragement, needs to be convinced as to why they need to change and so on. They need a lot of support and so on, so because of the difficulty in dealing with these other groups the tendency, even if you do set up a support structure ……………, so you find that you are trying to transform so that you bring everybody up but if the support structures are not in place you will find yourself actually making the gap wider (Policy writer L-RNCS).

And policy writer K-RNCS agrees with the statement:

In the process of the context of policy text production where there any thought given to implementation issues? No. So against the policies that are drawn out of C2005 was very much a visionary thing, not like the revised curriculum that were never involved or away from only visionary, grappling with the nuts and bolts of assessment, you know looking at the new structure but we were given a mandate or we were told that when you write the NS you need to consider implementation issues we have not done that but in our debate we were always saying, now who are we creating this for schools. So in that way first of all as policy of National I don't think that was clearly spelt out and that we have to look at what they are saying in the light of implementation issues, not enough on recommending but not talking about decisions, but to what extent could we really bring those instances for …, if you look at it you will see it. It was again time frames, the rush of the process and also I was part of provincial, the lack of vision about the policy making process, by National, policy document is not going to bring about change in the classroom (Policy writer K-RNCS).

There are a couple of issues regarding implementation: one is that policy development cannot be separated from policy implementation – and in a sense the Review process was a formal attempt at re-iteration. The alternative view is that the policy is indeed a statement of intent, to be realized over time. A third aspect is that the RCNS leaves open, for example, the question of how to deal with indigenous knowledge systems "the policy is not prescriptive" in that regard.

6.3.4 Summary

In Section 2 of this chapter the rational model of curriculum development envisaged by the national Department of Education from the lessons learned in the C2005 process did not fully consider the contested terrain of policy development and use that contestation as a springboard to launch the RNCS process. Once again, in practice, the process was weighed down by time constraints, responding to political pressures, inadequate conceptualisation of the design process resulting in imprecise briefs and professional abuse (these will be theorised in the next chapter). Other negative factors recorded were the nature of critique and the practical stresses of getting individuals to a working group meeting. There were positive spin offs to this process characterised by uniformity, structures in place to address public input, getting the curriculum development process right in an opportune time in South Africa's curriculum history and a determined effort to streamline and not re-invent the curriculum.

Section 3

6.4.1 Two Processes: What are the Outcomes?

In this section I draw features in the two processes that seek continuity or dissonance with each other. Since the RNCS process follows the C2005 development process after a period of review, it would have been logical to assume that lessons learned about the C2005 process would be incorporated in the development of the RNCS. I have organized the features dimensions of the two processes under the following headings:

6.4.2 Who are the policy actors and why where they selected?

In C2005 interested individuals were invited to a workshop (where the broad National LAC was formed) to conceptualise the rationale and outcomes for the Natural Science Learning Area. Nominations for the Technical Committee was invited through the Government Gazette. Although it would appear as if a broad consultative forum was created to develop the curriculum policy document only three members in the Natural Science Technical Committee did the actual writing. In the development of the NCS, the MPC members were formally appointed by the Minister of Education. Many of these members had either served on the Review Committee or had been Department Officials. Nominations for working group members were invited through a public advert and the MPC used particular criteria to appoint the chair and working group members. After the public input in July 2001, the four advisors that were added to the science group were chosen by the MPC. Advisors had to address particular issues that had risen as a consequence of the public input. There were more individuals (six working group members and four advisors) that were involved in the actual writing of the document.

Policy makers for both processes cited reasons of involvement in science initiatives, work in NGO's, leadership and writing skills as reasons for being included in the process. Policy makers in the C2005 process cited an additional reason of convenience for being involved in the process. Advisors to the RNCS process cited the critique of the draft RNCS document and their experience of OBE as reasons for being included in the process.

6.4.3 Who/What drove the Process?

The C2005 process was driven by the technical committee and the department officials. Although a broad, stakeholder forum for inputs was created, there were no structures in place to address public input. There are indications that the public input were not used when the final policy document was promulgated. Participation in the policy process was confined to certain stakeholder groups e.g., the extent to which learners and parents were consulted is unclear. Moreover in a large policy area with numerous institutions, nine provincial departments, unions, NGO's and particular interest groups, the representation and meaningful participation of stakeholders is structurally limited. The RNCS process is considered to be 'expert driven'. Policy writers however record the process as being driven by task team meetings and the public input rather than the experts in the committee. Drafts produced by the working groups would be critiqued in task team meetings against specific criteria by people who were not expertise in the learning area (in the C2005 process work of the technical committee in a particular learning area would be critiqued in a plenary meeting of all the technical committee members).

Unlike the C2005 process, in the development of the RNCS there were structures in place to collate the responses from the public input by interested stakeholders. These responses were constructively used in writing the final policy document.

6.4.4 Constraints and Strengths of the Policy Making Process

Common constraints that were elicited for both the processes were that of: (i) time-leaving little space to debate and reflect on philosophical issues, undermining the credibility of the process and corrupting the process. Policy makers were under pressure to deliver in a technical sense; (ii) inadequate conceptualization of the curriculum design process/imprecise briefs: the management were faced with the challenges of putting together the basic ingredients of a curriculum that is uniquely South African and yet will enable South Africa to complete globally. The challenge of what to put into the curriculum and what to leave out sometimes resulted in imprecise briefs with the ones the receiving end feeling professionally abused. There was also an uneasiness about the strengths of the management members. In the C2005 process policy makers spoke about uneasiness of the experience of members of the LAC. Additional constraints that were noted for the RNCS process were that of responding to political drives rather than pedagogical needs; the nature of the critique and practical stresses of attending working group meetings.

Common strengths to both processes were that of a period of intellectual growth. Policy makers in the NCS process also spoke of uniformity in design for all learning areas, a determined effort to address public input, the attempt at streamlining and not re-designing the curriculum and being part of a process at the opportune time in South Africa's transformative history where South African individuals were willing and keen to participate/ massified their participation through direct involvement in the process or through the responding to the invitation to respond to the draft statements.

6.4.5 Implementation Concerns

In both processes there were concerns about implementation but not in-depth discussions. There was awareness that what was to be developed was a wide open policy statement/ framework document with implementation guidelines to follow. Policy makers agreed that C2005 did appear symbolic or visionary and there was a sense that '*if you want to see change happening you have to put a mark somewhere*'. There was an intention for change but not much conceptualization and support of the change process. In the development of the RNCS a special implementation group was set up to look into issues of creating a macro implementation strategy and a framework plan to be developed by provinces. Working groups had to submit their concerns about implementation to the implementation group. There was also an awareness of the policy reality of schools where many teachers work with published curriculum materials rather than the actual policy document. This does not augur well for the roles of teachers to be able to interpret policy and become curriculum designers.

6.5 Concluding Remarks

In this chapter I have recounted the policy making process as told by the policy writers to illuminate the process, experiences, perceptions and feelings of the individuals involved. The process is after all a string of *coherently related events*. This chapter has captured, through the conversations, the complex and messy nature of the policy making process. The confessions that arose out of the conversations are tapestries woven from moments of critical reflection, sometimes exposing moments of uncertainty, and yet amazingly positive, fulfilling, creative and hopeful.

The model of development changed (though in both instances it was confused). C2005 paraded itself as 'stakeholder driven' but the various meetings were not especially effective, most of the plans and structures were never enacted, and written submissions were not used. Time was of the essence (but that was a political choice). Given that the revisions were to be essentially 'streamlining', a small-team approach was appropriate for the second phase. However, the teams this time obtained and used written inputs and in a way were more responsive to input than in C2005. (They also had the Chisholm Review to hand, and research data, and experience). Further, the Science and Technology groups worked together on much of the RNCS. The real power play was between the MPC and the science writing team for the RNCS process. Even so, in all versions, the writing teams were the prime determinants of the science curriculum.

The interactions within the group did not appear as cohesive as was indicative from the interviews. All of the writing team members insisted that the team was very cohesive, and worked hard on the intellectual problem especially. But responses to the questionnaires, on almost all questions, are widely varied – some felt everyone was 'heard' others said no, etc. And the data from the interviews did not always match the questionnaires. What would appear to be a logical process is in fact fraught with tension, confusion and contestation within particular policy domains. Whilst the Natural Science working group was not characterized by much political and practical tensions ('there were no strong voices'- their overriding concern was to deliver within the time frames), forces outside the group impacted on the group in an attempt to conform to a particular model of policy making. The essence of this chapter is politics, management and hence power (both bureaucratic and intellectual). The politics that are relevant here are the politics within management (the MPC). Time-lines were critical, and though policy writers complained about them, they did not question them.

Why did it all happen so fast? Why was there no outcry when the speed of development cast of, in turn, district LACs, provincial LACs, teacher involvement, opportunities to read and used the written submissions? Emanating from the data in Chapters 5 and 6 is the regularity[7] of governmentality and professionalisation. Governmentality allows the unmasking of covert and overt ideologies, politics and power, and the ways these are reinforced by structures. It allows one to move into a second level of analysis and work between rhetoric and operationally defined positions within the curriculum.

Professionalisation as a regularity extends the governmentality idea: the science policy writers were responding to three broad audiences: the government (through the transformation agenda), the international community of science educators, and to the local community of science educators. All these are part of governmentality, but the professional allegiances had a special place- the science educators felt their loyalty to science education very strongly.

In the story presented, there are many issues upon which I could focus. Choosing those that seem to be of most interest to the study, have most heuristic value, and which can be extrapolated from the data at hand to shed light on emerging policy lessons which I will engage with in Chapter 9. In the next Chapter I deliberate on the emergence of the particular problem in each period of reform as constituted by a grid of the two intersecting social regularities identified in this chapter.

[7] The term regularity is used here as a technique to maintain a particular social order, generally instigated by the state. What I allude to when I use governmentality as a regularity, is that a particular rationality of the government has, instead of changing the social order, in fact, worked towards the maintenance of a particular social order.

Chapter 7

Policy Archaeology Applied: The Grid of Intersecting Social Regularities

7.1 Introduction

In this chapter I will delineate the two regularities[1] that I have identified in Chapter six; discuss how they are necessary for the emergence of the policy problem[2] (the second arena of policy archaeology; how they shape the social construction of the problem (the first arena of policy archaeology) and; examine how these regularities constitute and shape the range of policy solutions (the third arena of policy archaeology). This analysis draws heavily from the work of Scheurich (1997) on policy archaeology that he proposes as a new policy studies methodology.

In Chapter 6, I have identified the two regularities as **governmentality** and **professionalization.** I posit that these regularities are necessary for the social construction of the policy problem in both the C2005 and the RNCS processes. These regularities intersect in a complex, grid-like fashion on the policy-problem axis. These intersecting regularities makes it possible for the policy problem to emerge as a problem, constructs the problem, and make the problem social visible. In Chapter 9, I will use the lessons learned from this level of analysis to draw out policy lessons for the South African context.

This Chapter has two sections: each section devoted to a particular regularity. I will show how the three arenas of policy archaeology identified by Scheurich (1997) can be applied to these two regularities. It must be noted here that these regularities intersect in a complex, grid like matrix; the separation here is only for organizational purposes.

[1] Recall from Chapter 3 that social regularities consist of patterns of thought and ways of thinking that permeate the policy process. Governmentality as a regularity is a way of thinking about the practice of government that maintains a particular social order.

[2] Note that the analysis here indicates that this is a 'problem solving' approach to policy – compared to, for example, a vision approach. The problem approach, almost by definition, is normative/ deficit based and is therefore regulated by the two regularities: governmentality and professionalisation.

7.2 Governmentality

7.2.1 Introduction

Governmentality is a way of thinking about practice of government (who can govern, what governing is, what or who is governed). It is a way of thinking, a 'rationality' capable of making some activity thinkable and practicable both to the practitioners and those upon whom it was practised. Thus this rationality consists of principles, goals and practices working together – often covertly. Foucault's ideas on governmentality have had limited penetration in South Africa, where the dominant approaches to policy analysis and critique since the transition have been structuralist and empirical rational in orientation (Tickly, 2003). Foucault (1991) uses the term 'governmentality' in two main ways (Dean 1999). The first is in terms of a general approach towards thinking about the state. Rather than seek to deduce an essential set of characteristics, essence or *a priori* interests that 'define' the role of the state as liberal Marxist accounts attempt to do, he sees the changing nature of the state as being a function of changing rationalities of government. In this view, governmentality can be considered as the art of government, i.e. a way of thinking about the nature of the practice of government (who can govern, what governing is, what or who is governed) (Gordon 1991a). This way of thinking is often taken for granted and is not open for questioning by its practitioners. It draws on ideas, theories, philosophies, and forms of knowledge about governing that are culturally embedded. In contemporary liberal societies, these forms of knowledge are derived from the human sciences, from disciplines such as economics, politics, psychology, sociology and education.

Secondly, governmentality has a more specific meaning as a way of marking the emergence of a distinctly new form of thinking about and exercising power in certain societies as opposed to sovereignty, which is a pre-modern regime of power where people are the subjects of sovereign institutions. People are forced by violence or the threat of violence to accept the authority of the state. Authority is thus enforced externally. Governmentality is a modern regime of power where people are citizens of a state. Power operates not externally but internally, by inducing people to aim for "self-improvement" which seems voluntary. Governmentality is a kind of governmental rationality that equates the well -being or happiness or productiveness of individuals with behaviors that reinforce the social order. It is an insatiable management of social spaces, social practices and forms. It is like a monster, without a conscious master, a headless monster, that must consume everything, that must bring all social reality within its taxonomical or descriptive regime, that ' must bring under management those zones of social life which have hitherto remained formless' (Procacci, 1991, p164). A characteristic of society – 'who should govern' or 'inclusion/ exclusion' looks different in a different rationality[3]. But the purpose is the same: to bring individuals and state together, for the sake of stability (and also change). Though individual government agents apply this mentality to their areas of responsibility, they typically are not conscious that they are proliferating a social regularity. These individual agents do not have bad intentions they are instead inscripted by and, in turn, inscripting governmentality. Policy makers are an integral part of this regime.

In the art of government, then, governing ceased to be seen as existing on the external boundaries of the state, it was inside the state, inside society. And Foucault emphasized that these arts presented governing as practices in continuity from the individual's government of itself, through the father's government of the household, to the prince's government of the state. The art of government sought to introduce 'economy', conceived as right management, initially a concept that applied to household government, into political practice. For Foucault, this concern, which develops more fully in the late 18th century, marks the beginning of the conceptual shift towards our contemporary use of the word 'economy' to designate an autonomous region of social relations. The modern state is a governmental state; its agencies are multiple; the techniques and tactics at their command diverse.

[3] One may question whether rationality is greatly different from a social or political philosophy? Perhaps the difference lies in the fact that rationalities are more covert and influenced by practices as much as thought.

Liberalism, by contrast, takes as its object of government 'society' and attempts to tailor governmental instruments and practices to the nature of social relations in 'society'. Governmentality is not static it changes in many ways as the nature of social relations in society.It is an activity aiming to shape, guide or affect the conduct of persons. A rationality of government is a way of thinking, capable of making some form of that activity thinkable and practicable both to the practitioners and those upon whom it was practised. Thus, all forms of government operate according to certain rationality. Some of Foucault's historical examples are the doctrines of government in early modern Europe associated with the idea of reason of state and the police state, another is the eighteenth-century beginning of liberalism, a third is post-war forms of neo-liberal changes in the welfare states. He sees them all as modern forms of government since their aim is to develop all elements of individual lives in such a way that their development also fosters the strength of the state. They have in common a will at once to totalize and individualize (*Omnes et singulatim* – all and each).

Following Foucault's work on governmentality, government is analysed by Rose & Miller (1990, 1992) in terms of the political rationalities and technologies of the will to govern, that is, to 'conduct the conduct' of others (individuals, groups, populations) or oneself. Political rationalities are regularities within political discourse constituting different ways of articulating and conceptualising government, and can as such be identified and differentiated by means of discourse-analysis. In particular one should pay attention to their moral form (concerning the fitting and legitimate powers of authorities, the ideals to which government should aspire and how tasks and responsibilities of government should be distributed), their epistemological character (how objects of government are conceptualised), and the use of language and technologies through which reality is made amenable to government (see Rose & Miller 1990; 1992; Rose 1999: 26).

The "main problem" is not to investigate if practices conform to rationalities, "but to discover which kind of rationality is being used" (Foucault 1981:226). In this perspective, rationality does not refer to a transcendental reason, but to historical practices; it does not imply a normative judgement, since it refers to social relations. One isn't assessing things in terms of an absolute against which they could be evaluated as constituting more or less perfect forms of rationality, but rather examining how forms of rationality inscribe themselves in practices or systems of practices, and what role they play within them, because it's true that 'practices' don't exist without a certain regime of rationality" (Foucault 1991:79).

Phenomena such as 'the social', 'community' or the distinction between 'state' and 'civil society' are seen as artefacts of government and analysed with regard to their function in the political rationalities, e.g. how such concepts serve to territorialise and legitimise government (e.g. Rose 1996). This is not seen as a question of implementation, but with reference to 'actor network theory' (Latour 1987), as a question of how to enrol persons, communications, procedures, things etc into a network that will make individuals and groups conduct themselves in certain ways. From this perspective, government cannot be explained with reference to the power of some particular actor or institution instead, the power of actors or institutions can be seen as an effect of government, in the meaning of successful enrolment of persons, procedures and things etc in a network. The research task in this study is to find out what rationality is operating, how it inscribes itself in practice and is inscribed by practice. Government structures and processes –including the 'limits' of 'government' – are part of that rationality. Thus governmentality is always diffuse so that subject/ object separations are problematic.

Foucault (1991) also holds that the state is a function of changes in practices of government, rather than the converse. Institutions are seen as products of changes in the rationale and meaning of the practice of government. So, the idea of governmentality is fundamentally concerned with the ordering of individuals around particular ideas, discourses or technologies. It implies a certain relationship between the citizen and the state – one concerned with demonstrating the appropriate "technologies of the self" and thus a moral component to social life.

Government refers to more or less systematized, regulated and reflected modes of power (a "technology") that go beyond the spontaneous exercise of power over others, following a specific form of reasoning (a "rationality") which defines action or the adequate means to achieve it. Government then is "the regulation of conduct by the more or less rational application of the appropriate technical means" (Hindess 1996:106). Technologies of government account for the systematization, stabilization, and regulation of power relationships that may lead to a state of domination (Hindess 1996). In other words, government is a technology of governmentality.

Foucault's discussion of neo-liberal governmentality shows that the so-called "retreat of the state" is in fact a prolongation of government. Neo-liberalism is not the end but a transformation of politics that restructures the power relations in society, i.e., neo-liberalism is a reconceptualisation of the state. What we observe today is not a diminishment or a reduction of state sovereignty and planning capacities but a displacement from formal to informal techniques of government and the appearance of new actors on the scene of government (e.g. NGOs), that indicate fundamental transformations in statehood and a new relation (not necessarily productive), between state and civil society actors. The new actors on the scene for the C2005 process were viewed suspiciously possibly because of the envisaged transformation in statehood:

> *The other thing that was happening was that there was at least 15 years of classroom experience among the NGOs. Quite apart from that right through the 1980s they were thoroughly disliked by the education authorities and yet nonetheless managed to bring about quite a lot of change in the classroom and learn quite a lot about what works and what fails. We were never consulted. We were eager to be consulted but they told us they'll call us in three to four years* (Policy writer A- C2005).

This encompasses on the one hand the displacement of forms of practices that were formerly defined in terms of nation state to supranational levels, and on the other hand the development of forms of sub-politics "beneath" politics in its traditional meaning. In other words, the difference between state and essence of government – that is, the art of exercising power in the form of the economy – is to have as its main objective that which we are today accustomed to call ‚the 'economy' (Foucault 1991a, p. 92).

This theoretical stance allows for a more complex analysis of neo-liberal forms of government that feature not only direct intervention by means of empowered and specialized state apparatuses, but also characteristically develop indirect techniques for leading and controlling individuals. The strategy of rendering individual subjects "responsible" (and also collectives, such as families, associations, etc.) entails shifting the responsibility for social risks such as illness, unemployment, poverty, etc. and for life in society into the domain for which the individual is responsible and transforming it into a problem of "self-care". One key feature of the neo-liberal rationality is the congruence it endeavors to achieve between a responsible and moral individual and an economic-rational individual. It aspires to construct responsible subjects whose moral quality is based on the fact that they rationally assess the costs and benefits of a certain act as opposed to other alternative acts. As the choice of options for action is, or so the neo-liberal notion of rationality would have it, the expression of free will on the basis of a self-determined decision, the consequences of the action are borne by the subject alone, who is also solely responsible for them. This strategy can be deployed in all sorts of areas and leads to areas of social responsibility becoming a matter of personal provisions (Rose & Miller, 1992; Rose, 1996: 50-62). For commentators such as Rose (1996), Harris (1999) and Dean (1999), the 1970s saw the emergence of 'advanced liberal governance' in western societies. According to these authors, this form of governance can be understood as a response to economic globalization and the shift from Fordist to flexible forms of production. This new form of governance has entailed a redefinition of the relationship between state and society.

How does the neo-liberal shift to devolution and accountability, the marketisation of schools, and the introduction of fees fit into science education and the two periods of curriculum reform? The most common conceptualisation of neo-liberalism is as a policy framework - marked by a shift from Keynesian welfarism towards a political agenda favouring the relatively unfettered operation of markets. Often this renewed emphasis on markets is understood to be directly associated with the so-called 'globalisation' of capital. The argument is a familiar one. New forms of globalised production relations and financial systems are forcing governments to abandon their commitment to the welfare state. Rather than formulating policies to ensure full employment and an inclusive social welfare system, governments are now focused on enhancing economic efficiency and international competitiveness. One consequence is the 'rolling back' of welfare state activities and a new emphasis on market provisioning of formerly 'public' goods and services. Science education fits in especially because of its place in the economy: the rhetoric of 'science for all' can be glossed with myths of meritocracy.

A useful distinction can be made between government and governance, and argues that while neo-liberalism may mean less government, it does not follow that there is less governance. While on one hand neo-liberalism problematises the state and is concerned to specify its limits through the invocation of individual choice, on the other hand it involves forms of governance that encourage both institutions and individuals to conform to the norms of the market. Neo-liberal strategies of rule, found in diverse realms including workplaces, educational institutions and health and welfare agencies, encourage people to see themselves as individualised and active subjects responsible for enhancing their own well being. This conception of the 'active society' can also be linked to a particular politics of self in which we are all encouraged to 'work on ourselves' in a range of domains, including the 'counter cultural movements' outside the purview of traditional conceptions of the political. Neo-liberalism (like any rationality) is insidious, in that it can be seen to be an expression of individual rights (and responsibilities) and democracy. But it takes a particular perspective on these values. This is all part of governmentality. Ball (1990) points out, we don't quite devolve responsibilities, because we surround the whole with accountability measures, punishments, rewards and controls.

Liberal governmentality retains and utilizes the techniques, rationalities and institutions characteristic of sovereignty and discipline but repositions them in accordance with the new object of liberal government. This object which takes the form of an administrative imperative to optimize the health, life and productivity of populations is referred to by Foucault (1994) and his followers as bio-power.

7.2.2 How does governmentality cause the emergence of the policy problem as a social constructed problem?

Although it is not made explicit by the policy documents or the policy writers it can be inferred that the problem group is the large majority of South Africans (predominantly Black South Africans) who suffered an inferior education system under the apartheid rule. Governmentality produces or constructs this problem population. It arranges the 'seeing' of this target[4] group as a problem group. Education policy can be seen as acting at the interface between programmes and technologies of government. In other words, education policies take the form of political programmes of government and attempt to use technologies of government to implement these programmes in a way that is consistent with the underlying rationality of government. This is not to say that education policy simply 'reflects' the dominant political rationality of the state. Indeed, in the South African context, education policy understood as a discursive formation with boundaries between the state and civil society has been subject to a range of sometimes conflicting rationalities and political programmes from within and without of the state both during the apartheid era and subsequently. Education policy, like other areas of public policy, is caught between these conflicting rationalities. The broad trajectory of the South African state is towards a version of the advanced liberal state that is characteristic of modern states elsewhere. It is underpinned by a form of neo -liberal governmental rationality and employs neo-liberal political programmes and techniques of government. These, however, bisect with more traditional liberal rationalities, programmes and techniques that provide continuity on earlier Liberal and African nationalist thought in South Africa and posit a role for the state in relation to social welfare functions (Tickly, 2003). Sovereignty in the new South Africa is based on a system of universal franchise and a constitution and bill of rights that are amongst the most liberal in the world.

Under apartheid, the 'bio-political imperative' was defined in racial terms as the

[4]The 'target group' between 1997 and 2001(the two reform periods) did not shift, although there were significant shifts in the government rationality from RDP to GEAR. In 1997, the primary goal was equity and redress; in 2001 it became 'high knowledge, high skills' – in other words, equity was re-interpreted as access to high skills, and the standards served a more constrained, more selective function than in C2005. In 1997, neo-liberal philosophies were not so strong, so the governmentality was different.

defence of the Afrikaner volk and ensuring the security, health, prosperity and well-being of white South Africans. The significance of the 1994 elections was that they heralded a constitution which is premised on the view of 'one law, one nation' (Constitutional Assembly, 1997) the extension of the bio-political imperative to encompass the population as a whole as one shall see, however, education provides an example of an area of policy which has been used to preserve and extend the bio -political imperative of groups defined in racial and cultural terms. The new system of government has deepened and extended the use of a neo–liberal rationality of government. In chapter 6, I had indicated that there were three levels of policy contestation: the macro, meso and the micro. Athough this thesis is centred on the micro domain, the ideas of governmentality proliferate all domains, although debated mostly at the macro level. The push for the neo-liberal agenda of government (although not strong) is evident in:

> *we had inputs from around the country and we were reading documents from other countries and pressure towards a ideal curriculum to get back into the world, too much into the world has been in a western context, that was my understanding of in Australia, America, Canada but South Africa isn't like that, its very much different. So what you have John Bray, they invited him to speak at one of the conferences at SAARMSTE, his message was you know how many ingredients are common for you to put together for a curriculum to have outcomes, assessment criteria, performance indicators, you know what do you need but really what can it do without. Now I thought that was a very important message that he said to us.* (Policy writer D-C2005)

The tension between economic instrumentalism and social redress (a truly South African curriculum) is already present. There rationality of government influenced how department officials conceived their roles and chanelled the process:

> *It was restrictive in the sense that we had people from the Department with a particular departmental agenda whatever that was, whether it was political or whether it was intellectual, whether it was bureaucratic or whatever, they kind of channeled this process, now that was not always a weakness, there had to be some channeling otherwise it would have gone off in a million different directions, but yes, there was this attempt to integrate and there were these people that made sure we did integrate, but I don't think it got beyond the level of rhetoric because I think the LA groupings did their own thing anyway (*Policy writer B-C2005).

Curriculum reform in the two periods under study provides an area within which the tensions between neo –liberal and liberal rationality are in evidence. Curriculum policy for the C2005 process was based on a version of outcomes based education and is central to the NQF which provides a qualifications structure for lifelong learning (DOE 2000b). OBE has been applied to schools in the form of the C2005 framework, which has subsequently been reviewed and revised following widespread criticisms (DOE 2000a). OBE identifies specific learning outcomes within eight learning areas and matching assessment criteria. In contrast to the highly content driven approach characteristic of apartheid education, OBE leaves it up to individual teachers and schools to make up the content to meet the outcomes (i.e., devolution of curriculum design). There was been an understandable panacea to content- the C2005 policy document in the rationale, raises the 'content-free' idea....

> *Learning Programme developers should take cognizance of the need to reduce content so that time will rather be used to develop the Specific Outcomes and their implied competences, attitudes and values. (NS-4)*

This was clearly government rationality at the time, clearly a response to the content-driven apartheid curriculum. There were two parts to this: to shift from 'content' to 'outcomes' and the issue of devolution versus central control. By 2001, this faith in devolution and teachers had diminished.

Another government rationality at the time was the stakeholder driven approach to curriculum development:

> *So the stakeholder driven was a rhetoric, the reality was to get something out quickly. There is a political necessity and we had to deliver.* (Policy writer E-C2005).

Several writers have examined policy developments at a macro-level by exploring the use of stakeholder processes during the transition period (Morrow & King, 1998; Unterhalter, 1998). Post apartheid South Africa has attempted to put in place the most elaborate and inclusive public policy process in Africa. The 'stakeholder' approach to policy-making adopted by the democratic government in 1994 has led to an evolution of an elaborate, multistage process that attempts to enlist as much input from the public as possible.

Policy documents of the Government of National Unity in 1994 used the term 'stakeholder' to refer to key interest groups in society (often business, labour, and the state, although in some cases 'women', the 'disabled', and 'youth' might also be included as apparently homogenous groups.) Stakeholder forums, these policy documents claims, would enable and broaden articipation in decision-making (DOE, 1995). However Unterhalter (1998) has argued that the stakeholder processes are in fact linked to the narrowing of the policy discourse. By co-opting different voices into the state machinery and by excluding majority communities with different concerns from policy debates and governance structures, stakeholder processes have enabled the silencing of critique of the State (Unterhalter, 1998). Muller (2000) has explored the relationship between policy positions of individual policymakers, and the broad, political, economic and social contexts that enable or constrain the options available, with regard to progressive educationists (Muller, 2000). He examined how intellectuals engaged in the mass democratic movement have become positioned as either critics or reconstructors by 'changing social forces and conditions' since liberation (Muller, 2000:267). In doing so, he shows how specific positions were not available within particular socio-political contexts.

According to Lungu (2001) this elaborate policy apparatus does not come as a surprise for three fairly obvious reasons. Firstly, the long history of racial discrimination, and later apartheid policies which systematically excluded non-whites from policy structures and processes, has led to a strong desire in the democratic movement to create more inclusive and transparent policy processes. Secondly, the fact that South Africa was among the last of the African states to achieve majority rule meant that it had the opportunity to learn and observe from the achievements, mistakes and omissions from other African states. Returning exiles, and the presence of a sizeable group of experts and scholars from African and other countries brought useful comparative insights into the processes of governance generally, and policy making in particular. Thirdly, South Africa is well resourced, by African standards to finance and manage elaborate policy structures and processes (Lungu, 2001). This did not pan out, as indicated by policy writer E- C2005, there were no structures in place to involve a broad consultative process as possible.

Consequently, the few that had the expertise and capacity drove the process, leaving minimal change in the social order:

> *we used to have big arguments about the difference between representation and participation and they made every attempt to make it representative but they didn't encourage participation, real participation. So there were times when it was very democratic and there were times when it wasn't. (Policy writer C-C2005)*

Whereas the process of designing the first version of C2005 was representative in terms of stakeholder involvement, its revised version was representative in terms of individual expertise and experience; involvement of departments of education; race and gender participants; and stakeholder representation in the Reference Group. Once again the rationality of government agents in terms of managing the process intruded:

> *Well it was labeled by National as a..... C2005 was described as a stakeholder driven process while the NCS was described as an expert driven process. And I don't think either of those were really true. Last night we spoke about what happened in C2005 in the LAC and so there were stakeholders in name only. With the NCS, by July it could not be described as a stakeholder driven process at all. It was being driven by the task team meetings. Coordinators would present and it would be summarily critiqued. One document would be held up against another and strong advice would be given by people who were not experts in the learning area at all.* (Policy writer E-on the RNCS)

This may as well be a defensible management strategy given the policy lessons learned from the C2005 process and the fact that the RNCS was merely to 'streamline' C2005, and this would be best achieved by a few minds, not many minds.

The progressive intent of OBE is evident in the set of specific outcomes in the C2005 document which: (i) maps the field – it defines 'scientific literacy' as it is to be represented in the curriculum; (ii) sets the learning purposes, in the form of demonstrable achievements. The outcomes are intended to objectify competences, not knowledge as such; (iii) to the extent that standards, or steps in achievement, must be defined for each outcome, the outcome indicates 'what progresses' as children reach the outcome; (iv) it articulates with the critical outcomes, and the overall purposes of the curriculum; (v) provides a useful framework for designing curriculum, teaching and assessment. The progressive intent of OBE, however, clashes with the neo -liberal framework of school governance and finance (to name but two of these). The problem has been that schools are unequally equipped to buy the materials and to make up the content, particularly as there is such an uneven distribution of well qualified teachers (Jansen 1998).

Policy writer E-C2005, comments on how low standards were being maintained, especially in poorly resourced schools (another indication of the maintenance of the existing social order):

> *There were evaluations being done of the training programme and what was happening in the schools. I think one of the major influence was the JETS report: Getting Learning Right, by Nick Taylor and Penny Vinjevold, a report by the President's Education Initiative research project and it was published by JET itself and they were basically saying that schools were not able to cope and from JET there was quite a strong feeling that C2005 had lost touch with reality and there were comments like this was a complete waste of time, what was needed was a simpler, clearer syllabus, more of teacher training and better monitoring of schools. It said that teachers were not teaching and that low standards were becoming acceptable.*

These tensions have led to a rethink of the basis of OBE in line with developments elsewhere. The corollary of a localized system of school management in other parts of the world has been a more prescriptive and content driven curriculum with an emphasis on summative as well as formative forms of assessment.

The recommendations of the C2005 Review Committee (DOE 2000a) and the recently revised curriculum framework (RNCS) advocate more central guidance and support for teachers and schools. The new framework is also written in the language of a 'national curriculum' (DOE 2002). There is also a tension, however, between conflicting ideas about what ought to constitute the outcomes of education in OBE that are linked to conflicting rationalities of government. This tension was expressed, for example, in debates during the 1980s and 1990s between representatives of business and the trades unions about what ought to constitute suitable 'competencies' in relation to adult education and training (DOE, 2000a). To simplify the debate, whereas business has historically advocated entrepreneurial and narrow technical skills (in line with the trajectory of policy from the de Lange Committee onwards), the trades unions have emphasized a more holistic view of competencies commensurate with the idea of 'critical citizenship', i.e. citizenship that involves an awareness of workers rights and freedoms and an ability to act on them (Unterhalter, 2000). In the 1980s, the debate between instrumental education and social purposes was strong. In the event, the unions were the powerful voices in shaping OBE and the NQF, and much of their concern was instrumental – to improve worker skills. The social function was more muted at that stage.

Both the construction of the 'entrepreneurial individual' and of the 'critical citizen' implied by the two sides of this debate are reflected in national policy documents (see, for example, DOE 2000c, 2002). It is the former, however, that is increasingly likely to predominate as it is more overtly linked to the development of an enterprise culture in keeping with the new market discipline. Indeed, the trajectory of the new curriculum does appear to be moving more towards a neo -liberal view of citizenship. What is also emerging in the new curriculum is a re-formulated version of critical citizenship that emphasizes national unity based on 'core values'. In place of a radicalized notion of workers rights, the new construction of citizenship is more in keeping both with classical liberalism and with recent shifts in neo -liberal thought globally. What is increasingly emerging as the object of South African education policy is a localized version of the neo -liberal homo economicus (Peters 1996) that combines the 'entrepreneur of the self' with a liberal notion of the social good based on a common set of values. Both the neo -liberal and liberal notions of citizenship, however, are potentially in conflict with the localized system of risk management. Different versions of 'democracy', 'citizen' and 'equity' that are competing but submerged have emerged: one in terms of participating in social development (with a strong orientiation to the collective good), the other in terms of participating in economic development through the individual enrtrepreneur.

In the South African context, it is not clear how local communities will define citizenship. It may be that some school governing boards will define it in relation to ethnic rather than national affiliations. Rationalities of government must respond to and contain economic and political change. Likewise, they also provide a lens through which these struggles are understood and interpreted and play a key role in defining political and economic subjectivities and possibilities. They are, in short, contested (Tickly, 2003). In the next part of this chapter I will explore how these competing ideas have manifested themselves in the two reform periods (C2005 and the RNCS) in the developing the natural science policy documents.

7.2.3 How did governmentality shape policy choices made?

Because of the before conscious thinking, pre-conceptual frames produced by the grid of social regularities and embodied throughout the social order, certain solutions and not others, are seeable and knowable by social agents. The policy problem in the South African context was large: it called for a major restructuring of social, health, and education services and questions about the social order itself. The intentions and policy choices were noble, but were largely constrained by the rationality of government in bringing about a co-ordinated re-structuring of all aspects of schooling (see earlier discussion on C2005 and tensions with the neoliberal agenda). In many aspects, e.g., in the conception of scientific literacy, goals of science and the specific outcomes there has been remarkable challenge to the dominant social order and rationality of the government. Yet, in other aspects, for example, the choice of content policy writers were constrained by neo-liberalism (globalisation) and their own conservatism (see discussion on content for C2005 in Chapter 5). There were clear intentions not to dilute 'science' for the sake of redress.

In South African policy development and curriculum policy development in particular, this broad trajectory in the epistemological basis of policy has been continuing since 1994. One mechanism that has been significant in introducing new techniques of government has been the widespread use of overseas consultants and management consultancy firms. These have been instrumental in catalysing the development of new management techniques and systems in education, health, social services and other spheres. In disciplinary terms this has meant extending and deepening the use of statistical techniques, neo -classical economic and management theory. Their work has helped to link social policy in South Africa to a global archive of knowledge about populations and suitable policy options held by the international financial institutions and sections of the donor community (Tickly, 2003). This was clearly a catalyst in the C2005 process:

> *Going back to the Department of Labor- Generally labour wanting to try and narrow the mental-manual gap in the curriculum. In September of 1996 we had a lot of speakers, we had the people from the Scottish Vocational Educational Council and we had some Australians and so on all talking about the process and the idea was to try and structure OBE and what it would look like and then we got together in subject areas, it was as that point that we actually named the thing the Natural Sciences, because they wanted to talk about science, so we gave it that name and I personally kind of pushed that and pushed that so we could include all the sciences in that. And at that stage we had what we loosely called Learning Area Committees (LAC)* (Policy writer B-C2005).

The point here is not so much the use of overseas consultants, but the rationalities they brought with them – from the World Bank to John Bray, they tended to the neo-liberal position, and directly and indirectly urged the government in that direction. For the RNCS process, the bringing in of overseas consultants were minimal, if not absent. Evaluative studies on the implementation of OBE were conducted by the state (the President's Initiative) and other organizations, e.g., NGO's. Important work on converting the C2005 document to a guideline document based on the Australian Profiles was also taking place in the GICD. This is a case in point: the Australian documents were helpful because they represented a position that the writers saw as compatible with South African needs and thinking. It was assured that individuals brought in during the second stage of reform (RNCS process) had knowledge of OBE and some level of curriculum mangement. Policy writer E- RNCS comments on constraints from management (presumably who had developed some level of curriculum management since C2005) that shaped policy choices:

> *So in the writing up to April 2001, which was obviously the July document the challenge really was dealing with the brief in the task team meetings: that content should not appear in the document, and we were aware that content had to appear and so it became a matter of trying to second guess the task team and deal with the content in some way that gave the reader some indication of what's to be learnt and taught. We probably restarted the document. I don't mean edited the*

draft, but we went back to the drawing board three times and in the end we just gave up and produced the document of July 2001, which reservedly was heavily criticized and I think that most of us felt almost vindicated by the criticism that poured in.....

The stronger role that the DOE took in 2001 (the expert phase) compared to 1997 (the stakeholder phase) is probably an expression of tighter control from the Centre (MPC). The grade-based standards and the call for high knowledge high skills are both consistent with neo-liberal thinking. The interesting thing is that, in many ways, the Science team subverted the central controls – especially because, in having to revise the NCS so dramatically, the central control systems were no longer operating so strongly, hence Science managed 'special rules' such as the 70/30 rule, and the distinction between outcomes (the policy) and content (in a separate chapter). Also, in the development of the RNCS a special implementation group was set up to look into issues of creating a macro implementation strategy and a framework plan to be developed by provinces. Working groups had to submit their concerns about implementation to the implementation group. There was also an awareness of the policy reality of schools where many teachers work with published curriculum materials rather than the actual policy document. This does not augur well for the roles of teachers to be able to interpret policy and become curriculum designers. This again presents tension between the liberal and neo-liberal agenda and does not argur well for challenging the social order if teachers relie on externally written curriculum material.

7.2.4 Summary

In this section, I have attempted to show how rationalities of government have both caused the emergence of the policy problem and the shaping of policy choices. I have presented 'snippets' from Chapters 5 and 6 to illustrate the reproduction of the dominant social order. The new form of economic bondage (i.e., the new conservative economic policies associated with corporate-driven globalisation) manifested itself in two ways: conservative fiscal policy and a mindless assault on public spending, including spending on public education. The direct results for the education system and educators in South Africa include the following: (i) Lack of resources to address racial inequalities in the education system. According to some researchers (Taylor, 2001), inequalities have increased since the advent of democracy; (ii) Curriculum reform has been compromised by the absence of critical resources for training and provision of learning materials (iii) limited access to education by transferring responsibility to parents through imposing school fees. Many communities subsist in dire poverty; (iv) Chronic, job insecurity amongst teachers as rationalisation and rumours of downsizing abound.

7.3 Professionalization

Professionalization works closely in tandem with governmentality. It extends the idea of governmentality to explore how the science policy writers were responding to three broad audiences: the government (through the transformation agenda), the international community of science education, and the local community of science educators. Professionalization is a proliferation of professions brought in to treat and manage the citizenry, i.e., produce disciplined, productive citizens. Once again, the larger implications of this goal are not evident to the professionals themselves. Like government agents, professionals operate with the best of intentions; indeed good intentions are typically one facet of their professional socialization. Consequently, while professionals function within a mindset that legitimizes the need for and positive value of their therapeutic or transformational or management theories, the theories are instantiational ideologies, the regulative purpose of which is to fashion productive citizens according to the norms of the current social order, i.e., to normalize citizens. Productive citizens continually relearn 'right behavior' by the public display of 'wrong behavior', especially through the social process of identifying social problems, problem groups, and policy solutions. The labeling of problem groups by social agents, particularly by socially legitimated social agents like professionals positively disciplines productive citizens by defining what a proper productive citizen is and by reaffirming the productive citizens' goodness or correctness. Popkewitz & Simola (1996: 121) note that the modernization inscribed in professionalization joins political rationalities with the production of the disciplined and self-reflective individual. Educational practices among multitude of practices associated with the emergence of modernity played a central role in the increasing professionalization and bureaucratization of western society and they had a direct impact on all sections of society. They bring their own rationalities, covertly as well as overtly.

In the preceeding discussion I have shown how governmentality played a critical role in the public identification of the problem group. The describing, numbering and naming processes of governmentality, which includes policy processes, provide a description of the problem group that can be circulated in both academic media and the public media. As newspapers and television programs repeatedly display (make socially visible) this problem group, and academics legitimate this the groups designation as a problem through journal articles, books and conferences dedicated to the problem, the problem is made real. Consequently, like the doctors of social diseases, professionals of all sorts including educators, social workers, health workers, and psychologists are called forth to treat the problem group with the chosen policy intervention (Scheurich, 1997). In many cases it is this group of professionals through their critical endeavours of the state and its endeavours make visible the policy problem and the problem group. These professionals then use their knowledge to adjust or transform the social group. The public performance of the treatment of the problem group by the professionals typically satisfies society that it is doing its best.

The roles of professionals are important in a number of ways: (i) their use contains the idea of 'experts' including the corollary of narrowness; (ii) they are networked to a (global) profession, an hence are under the influence of ideas that dominate professional discussion; (iii) they have two allegiances which are in tension – one to the profession, the other to the State; and (iv) they can be coopted to particular positions, whether derived from government or their professions. In this study, policy writers as one domain of professionals were brought in to treat the social problem. The analysis here will be limited to the policy domain and not the domain of practice where teachers would be the key professionals in 'treating' this social problem. In the C2005 process the structure did not allow for teachers to be part of the policy writing process since teachers were 'not available' to participate at this level. Also they were perceived to not have the skills to participate in curriculum issues. This has implications for devolution of curriculum that was on the curriculum agenda at the time- i.e., the professionals here were the 'curriculum experts' and teachers the 'classroom experts'- experts that were to realize policy intentions on the ground. Criticism from many educators has been that the teachers most likely to succeed at implementing the new curriculum and input into its development process are those from priviledged schools with enabling resources. Jansen (1999) comments on the elite corpus of reachers that have been involved in the process:

> A small elite of teachers, often expert and white, have driven the Learning Area Committees and other structures in which OBE has developed. The sad reality is that the overwhelming majority of teachers simply do not have access to information on OBE, or understand OBE in instances where such information may be available. In other words, there is not a process, systematic and ongoing, in which teachers are allowed to conceptualise and make sense of OBE and curriculum policy. In a cruel twist of history, teachers continue to be defined as 'implementers' and even in this marginal role, official support is uneven, fragmented and, for many teachers, simply non-existent (p.151).

For the RNCS policy writers were formally appointed to their positions:

> *Yes, we were formally appointed, but to get onto the working group there was an advertisement in the newspaper inviting nominations of people to be on such working groups. That was in about Oct 1999 and I got a call from somebody who would actually have been ideal for the working group saying would I accept being nominated. So I said all right, I'm not sure what it is but put my name down. I contacted other people asking them if they'd like to be nominated and so in this way a network had already begun, starting of from the really public advertisement where anyone can nominate anyone else. It was right at the end of 1999. So how that list was put together, I do not know but I have no doubt that there was some strong debate behind the scenes before the list was finalized. That was not in the Natural Science Learning Area that was in the Department of National Education, the MPC. (*Policy writer E-on the RNCS*)*

It would appear as if the point of 'selection' was to choose people who professional allegiances were consistent with government's position, at the same time as having professional credibility. It was a group of experts brought together to legitimate and suggest a treatment for the policy problem. Policy writer A- C2005 sees two factors as crucial to the characteristic of such a a professional: intellectual strength and identifying with democracy:

You get terrains of struggle in the streets where the power of the mass counts, then you have terrains of struggle which are intellectual, where you got a committee of ten people who are brought together to do something where, in that kind of forum, the numbers don't count, the muscular strength doesn't count. What counts is your intellectual strength. So even though we were in minority we managed to make sure that the new curriculum was not seen as disinterested [in social values]. It was part of the transformation it was part of identifying with democracy. It cannot remain neutral. Either you are with democracy or you are not with democracy (Policy writer A-C2005).

Greater public consultation and communication in policy development is seen as a way to re-legitimize governmental action. In the C2005 process, there were clear intentions to involve a wide range of people as possible, but the extent to which this was strategy as a technique that would strengthen the policy process is evident in:

I think National Education would claim that there was. But the meetings, 90% of such meetings were taken up with presentations and explanations of what things were and you can't expect people to make a response that is not clear. Well there were comments and submissions. There was input but there was no place to put it in. The process had rolled on. (Policy writer A- C2005).

Policy writer B- C2005 speaks about how in theory it would appear as if a broad as possible public was consulted but the practical realities of dealing with the submissions and time pressures weighed the process down:

There was a lot of response to the documents that were initially floating. I am not sure whether the documents were floated as broadly as the new governments policy development process required. But there was a lot of talk about how policy would be developed and in fact in many areas policy was developed through the most broadest process that happened anywhere in the world and many policy makers were coming in and looking at this and saying wow, you guys are really doing something new here. While the education documents, the curriculum 2005 preliminary documents, the promulgation of that, the technical committee in early 1997, the documents went out for public comment and debate and then there was responses brought back and these responses which came back to that reference committee ……..looked at that stuff and said there's too much work here and they just threw it away. ………… there was not a single thing in that document that had any influence on the documents that were promulgated and so that part of the process was corrupted by the need for speed (Policy writer B-C2005)

For the RNCS process, there was a re-newed and strengthened effort to include public inputs and to learn from lessons of the C2005 process. Policy writers L and J-RNCS see this as one of the plusses to the process:

one of the plusses I was happy about was the seriousness with which each comment was taken, I also wrote after the first draft, I don't know whether it was the reason why I was invited but I was really impressed with the way, there was a real effort to try and operationalize what people had said (Policy writer L-RNCS).

I think that's what I just said, when you look at the challenges of having such a big group, I mean I don't know of any country that has done it in that way and I think the input of the public was very important, I think that those groups have been very important (Policy writer J-RNCS).

Interestingly enough, for both the C2005 and the RNCS processes there has been no lobbying by pressure groups those groups that responded to public inputs did so in a spirit of contributing rather than unearthing the process. Perhaps another key point here is that those who participated in the public sessions and provided critiques and inputs were usually more science education professionals – from academia and unions much more than from teachers. For the RNCS process in particular, forums were created, through the media and other forms of publicity for the public to respond to the documents. This input into professionalisation has clearly impacted on the RNCS policy document, especially after the first disastrous draft in 2001.

Now ……….and I we decided that we would continue working in September, October, November, December. We continued because we knew that the time they had given us was limited. So we managed to get most of the comments that were coming through because we had established a network. People were not only writing directly to the MPC but they were also writing to us. So when we went to the December meeting we had a plan of action on how to proceed (Policy writer N-RNCS)

The new professionals play a pivotal role in promoting and facilitating this strategy. In the process new kinds of policy rationalities and practices begin to develop that seem to be an eclipsing older types and styles of policy formation and expertise. Key instruments in the repertoire of the new professionals are the various techniques of accessing and gauging societal attitudes and sentiment. Indeed they argue that decision-makers use 'crafted talk' that draws on polling information to convince the public that policy is contiguous with their moods and needs, even when the policy has its origins elsewhere (Jacobs & Shapiro 2000; Shapiro & Jacobs 2001). In the RNCS a determined effort was made to consult international documents and frameworks in re-working C2005:

So what I did earth and beyond and I looked around for curricula models, I looked at the Australian model, the New Zealand model and the British material and I looked at quite strongly the American, what happened in America curricula statements that they had there. So really it came from trying to see what can we.., we've become kind of conventional around these kinds of process, you know look into those frameworks and look at how we can weave it into what we are trying to do here. But I think behind this is primarily between the American version and the Australians, I found the New Zealand one a bit different and then, ja we tried to make something for ourselves. (Policy writer I-RNCS)

The point here is that these documents were not consulted in a vacuum as representative of the expert professional opinion but gaining access to these and understanding the politics of the source country. The other critical dimension concerning policy and the new professionalism involves the rise and proliferation of independent agencies engaged in research on public policy issues, the crafting of policy and the influencing of public opinion, operating at national and global levels (see *inter alia* Bakvis 1997; Denham & Garnett 1999; Smith 1991; Stone 1996, 2000a, 2000b; Stone *et al.* 1998; Struyk 2002). These agencies include think tanks, independent policy institutes and certain kinds of political consultancy firms. Increasingly governments, parties and other organizations have drawn on these agencies services and in some case become heavily reliant upon them for sourcing policy and its development. For the C2005 process, (and possibly other reform processes), some organizations are seen as legitimate (and others not) to influence and participate in the process. There was a feeling, particularly amongst those from the NGO sector who had many years of classroom experience, expertise and the political right to give input, that the consultation process excluded them:

The other thing that was happening was that there was at least 15 years of classroom experience among the NGOs. Quite apart from that right through the 1980s they were thoroughly disliked by the education authorities and yet nonetheless managed to bring about quite a lot of change in the classroom and learn quite a lot about what works and what fails. We were never consulted. We were eager to be consulted but they told us they'd call us in three to four years (Policy writer A- C2005).

For those that were involved in the process, their involvement was constrained by rationalities of the government:

So, the people like me who worked in NGOs for much of our professional lives we knew what the situation was out in the township, we wanted to be seen, to be heard. On the one hand we were trying to make useful constructive input and on

> *the other hand some of us were writing letters saying please don't do it like this, it's not going to work* (Policy writer E-C2005).

In the early 1990s, as the power of the apartheid regime was dissolving, the scale of popular protest waned and educational leadership fell into the hands of a few key individuals with organizational ties to the ANC (Unterhalter, 1998; Chisholm and Fuller, 1996). In terms of remedying the past injustices of apartheid education, reform required completely overhauling the education system, and what was brought in to fill the void was the product of time and of power struggles (Spreen, 2001). In the tide of democratic euphoria, NGOs and international aid agents were all trying to get in the door in South Africa and OBE was a likely candidate for their attention. This period was characterized by the emerging government's need to legitimate itself (see the emphasis on policy rhetoric in sections 6.2.3 and 6.3.3 of Chapter 6) by broadly constructed policy frameworks that had wide appeal and provide ready- made policy solutions to a myriad of social problems. Appropriation of OBE was part of the government's need to demonstrate leadership, accountability and its ability to establish a coherent plan to dramatically change education. In the RNCS, important work carried out by the GICD, RADMASTE and other units were quoted in the Roadmap document, as critical documents for consultation by the working groups. This added dimension was critical to the work of the professionals: the policy writers.

Beyond this, these 'independent' policy agencies are not just a source of expertise, research, and advise on policy issues. While some are notable for their strong ideological orientations, many become independent sources of political pressure themselves, propagating research on policy issues, setting policy agendas, and cultivating communities of opinion. This raises the issue of the blurring of research capacity and policy advocacy, especially in relation to the status of outsourced government policy. As in the case of the insinuation of professional communicators into governmental communication, this professionalization of policy through outsourcing poses the question of the accountability of non-official expertise in a democratic polity (Considine 2002). For the C2005 process, international consultants participated in the Curriculum Coordinating Committees, Reference groups and Learning Area Committees but took a background role- possibly to legitimize a process of internal iniative for a post apartheid South Africa. The emphasis of policy making shifted to understanding and defining a South African OBE. International consultants did however play a key role in legitimating[5] the problem and the problem group by participating in debates (in the media), workshops and in national conferences:

> *So what you have John Bray, they invited him to speak at one of the conferences at SAARMSTE, his message was you know how many ingredients are common for you to put together for a curriculum to have outcomes, assessment criteria, performance indicators, you know what do you need but really what can it do without. Now I thought that was a very important message that he said to us* (Policy writer D-C2005).

The overriding theme is that public consultation is crucial for revitalizing citizens' sense of political efficacy, and raising the quality of public debate, all of which is essential to generate consensus on complex and long term matters. Liberatore (2001) offers some detailed insight into these changing conditions. In particular she outlines three novel components in the contemporary relationship between knowledge and decision-making. First, there is the paradox that science is increasingly called upon to legitimate political decisions while at the same time the legitimacy of exclusive claims to scientific 'truth' is under duress. Second, knowledge production and decision-making has shifted in part at least from the public to the private sector even though societal problems remain public (e.g. health, environment) or have an impact on citizen's private life (e.g. reproductive choices, privacy). Third, the growing call for greater citizen participation has the potential not only to enrich the relationship between decision-making and scientific knowledge but also to further destabilize what is already a faltering relationship. Liberatore identifies the growing complexity of contemporary societies and the reorientation of democratic arrangements given citizen disaffection as two of the main contributing factors in the new relationship between knowledge and decision-making. The condition of complexity intensifies uncertainty and thus increases the demand for knowledge in decision-making. Yet at the same time, there is the recognition that complex conditions cannot be brought under unilateral control. Equally, citizen

[5] The international expert is another professional brought in to treat the problem. The point here is not to discount the leadership of experts but to indicate that their presence and practices (e.g., through workshops, publications etc) makes the policy problem 'visible'.

disaffection leads to a quest for new types of accountability often pluralistic in form that open up possibilities in which non-official and competing voices demand to right to be heard in decision-making. The confluence of these two factors—complexity and new forms of accountability—leads to an important outcome: 'the expansion of the previously relatively closed networks which provided expert advice to decision makers—both public and private—to more open knowledge networks serving as input to public debate and deliberation' (Liberatore 2001: 118).

This marks the shift away from the older exchange logic to an informational logic. In this new setting, political and public communication is obviously more than simply a consultation and information exercise in the earlier unilateral sense. This new recursive system of policy coordination is seen to require new rationalities and practices. Specifically it requires new forms of collaboration among various types of actors given that no single actor or group can possess the range or depth to integrate all the pieces into coherent whole. In this sense, the new approach is far more than pronouncements from one high on new policy. It demands that key stakeholders be identified and involved in the process, and that interfaces be developed that enable knowledge pooling, learning from experience and evidence, and further coordination of policy initiatives.

In this section, I have shown how the activities of professionals of the policy process and those professionals influencing the policy process, has socially constructed the policy problem and shaped the outcome of the policy.

7.4 Concluding Remarks

These two regularities are but two of the social regularities that comprise the dominant liberal social order, which constitutes that which has become visible and acceptable within that social order. They operate like a grid that generates what may be seen and talked about. This does not exclude the possibilities of other regularities. It is the complex interaction of these two regularities that constitutes the problem, the problem group and the policy solution. The grid is epistemological and ontological, it constitutes both who the problem group is and how the group is seen or known as a problem. The labeling of the target group as a social problem is critical to the maintenance of the social order. Other possible problem groups do not become socially visible as a problem group. As newspapers and television programmes repeatedly make socially visible this problem group, academics legitimate the groups' designation through journal articles, books and conferences (Scheurich, 1997).

In Chapter 8, I will explore how the policy process and the resulting documents express and further/ not social justice, democracy, social critique and empowerment.

Chapter 8

Inclusivity

Is it possible to base systemic curriculum reform on principles of social justice?[1]

> *You see in C2005 there were issues such as human rights issues, social transformation issues, indigenous knowledge, environmental issues, but it did not come through very clearly. That part it was upfront and there was quite a lot of debate and discussion and papers presented at National level at the Ministerial Project Committee (MPC) about human rights, about social justice issues, about social transformation, about animal rights issues, that's going to come out quite clearly in the curriculum and about indigenous knowledge and so on and so forth. So in other words it was upfront in the debate, not only for science but for all other learning areas* (Policy writer N-RNCS).

8.1 Introduction

Inclusivity claims a particular place in this thesis because of the critical research position adopted. It has also been fore-grounded as a key agenda of the state post apartheid. This chapter will explore how the policy process and the resulting documents express and further/ not social justice, democracy, social critique and empowerment. Some of the issues of inclusivity to be included in the discussion of this chapter are: race/class, gender, human rights, access and equity. The issue of race is an old regularity in Western civilization, in South Africa it has gained prominence as an outcome of years of apartheid. Race has assumed many different forms over different historical periods. Scheurich(1997) finds 'white supremacy' a more apt word for race. South Africa has a long history of white racial domination. Apartheid education was characterized by the use of the curriculum to promote social inequality, racial segregation, and differentiation on the basis of perceptions of abilities (NEPI, 1993). The so-called Bantu Education system of the past was premised on dividing learners along racial lines, systematically under-resourcing the majority black population and was underpinned by a curriculum riddled with racism and sexism and designed to keep people in their place. The "Peoples Education" Movement came into being to address the politically legitimate question of

[1] Inspiration for this title is derived from Willis and Johnston (1998).

participation and inclusivity. OBE initiatives had to be locally legitimated by emphasizing redistributional framework and addressing the concerns of equity and redress, and reflecting a dramatic departure from the former apartheid system and promising a change for the better. A priority for the first democratic government was the need for curriculum reform. South Africa needed curricula which would address, amongst others, the following: (i) the need to develop values to enhance democracy, human rights and non-racialism; (ii) the need to meet the needs of a rapidly changing labour market in the era of globalisation, with increased emphasis on imparting marketable skills, requiring a major shift towards the teaching of science and technology; (iii) the need to move away from highly authoritarian methodologies towards more learner-centred methods, with the aim of developing the full potential of the learner and encouraging a more critical and informed citizenry. On the other hand, new government leaders had to signal that they were constructing policy reforms that were recognized as fair, equitable and in line with 'world class standards' (Spreen, 2001). These sometimes, competing demands required democratic consultative forums to validate the content and direction of OBE. Hence the OBE language at the national policy level tended to be driven by economic concerns, while when it reached the more concrete classroom level it was about equity, access and redress (Spreen, 2001).

In many ways the transitional state can also be characterised by what Jansen (1999) described as 'an over-investment in the symbolism of policy rather than a serious consideration of its effects in disadvantaged communities' (Jansen, 1999:5). Throughout its implementation, many South Africans became increasingly skeptical about the nature and direction of OBE and began questioning whether leaders had really thought through the pedagogic implications of an outcomes-based system and the integration of education and training in a country plagued with inequality and ill-prepared teachers (Spreen, 2001).

8.2 Expressions of inclusivity in the policy documents for the RNCS and C2005 processes.

The RNCS process had a special interest group devoted to issues of inclusivity: called the human rights, civic responsibility and inclusivity working group which was tasked to consider issues in relation to ELSEN, primary and secondary language, racism, sexism, poorly resourced schools, environment and, so on. The principle of social justice, equity and development is clearly stated in policy documents. The curriculum can play a role in promoting human rights and social justice. In some countries this is done through subjects such as civics or though the promotion of community service programmes as part of the curriculum. The Review Committee for C2005 recommended in preference to these 'add on' approaches that human rights education and education for civic responsibility should 'be infused though all learning areas'. The supporting document presented to the working team for the RNCS process states that:

The C2005 Review Committee also advocated a high knowledge and high skill curriculum as a means to promoting social justice, equity and development. However, this begs the question of how this is to be done. The NCS suggests two ways. First, the curriculum can define for all learners the goals and outcomes essential to success in a rapidly changing world. In other words the curriculum should, for reasons of equity, set out the minimum knowledge and skills and values learners require, to enable them to proceed to the next level of the system. The less defined and less explicit the curriculum the more this will advantage already advantaged teachers and learners from middle class backgrounds, for reasons of prior familiarity. For many teachers and learners in disadvantaged schools the core skills and knowledge for progression in lifelong learning are not obvious – this is the very nature of their disadvantage. For this reason the curriculum should make explicit and not hide the 'rules of the game' from disadvantaged teachers and learners, leaving them without visible and defined scaffolding for progress. A second way in which the curriculum can and should promote equity and social justice is to make explicit the links between the learning outcomes and the resources required to achieve those outcomes. The relationship between particular resources and particular learning outcomes (knowledge and skills) cannot be left to chance especially for teachers who have received no or inadequate training in the field of study. Clearly, some of the learning outcomes in any curriculum presuppose resources (teacher knowledge and learning support materials) not available to learners. The identification of expository texts, learning support materials, assessment exemplars and examples of learners' work will assist teachers to teach to the learning requirements, assist government, parents and learners to monitor teaching and learning, and help those allocating resources to *understand the consequences of their actions in terms of learner performance.* (Roadmap document- RNCS)

There are two competing logics: equitable access to 'powerful' (universal) knowledge, versus localized needs. In South Africa, the history of Bantu Education made a 'single national curriculum' a vital expression of equity, but that national curriculum could not afford to privilege just one culture. This required finding a balance between national definition and local freedom. Devolution of curriculum design according to broadly defined outcomes and clearly articulated principles was the chosen solution. This means that achievement of equity is largely dependent on the quality of local curriculum design and teaching, but the conditions in schools are hopelessly unequal, so that the policy is bound to exacerbate inequalities – at least in the short term. Thus ideas of inclusiveness take their greatest expression at the local level – in choices of content, contexts and pedagogy. Policy is less significant than what happens at implementation. The curriculum documents need to make explicit the learning outcomes and the resources needed to achieve this. This was not done in either of the two processes. Although there was greater clarity of assessment standards and progression in an outcome in the RNCS policy document, there were no clear guidelines on how these values of human rights and social justice could be achieved. Also, in the C2005 document, assessment was not specified. The importance of assessment in maintaining the social order and social control has been well documented (Lubisi, 1999; Lubisi & Murphy, 2002). At the policy level, the key factor in equity is not so much curriculum as is assessment and accountability. Localization of curriculum requires localization of assessment, so monitoring of schools and students becomes difficult. Having conceded this, there is still some room in the curriculum documents for 'inclusiveness' – e.g., in the incorporation of African knowledge, rural experience, indigenous knowledge etc, but this has to be legitimated as 'high knowledge, high skills'.

Given that achievement of equity is largely dependent on the quality of local curriculum design and teaching, and that the conditions in schools are hopelessly unequal, the policy based on principles of social justice is bound to exacerbate inequalities – at least in the short term. I base my argument on the principles of integration and learner centeredness that are embedded in both the C2005 and the RNCS documents; the choice of content and the philosophical demands made by the documents of the classroom teacher and the common outcomes. C2005 has attempted to weaken the boundaries between subjects and have advocated integration at three levels: The document states that the exemplars within the Range Statements '*leave room for cross-thematic issues*' i.e., integration between themes of the discipline of science. Reference is also made for integration with everyday life e.g., '*these other outcomes relate the Natural Sciences and its array of knowledge, concepts and principles to practical daily life situations.*' (NS-11) and '*linking everyday knowledge with scientific interpretations*' (NS – 20). The document does not explicitly state how the Natural Science learning area could be integrated with other learning areas, even in the exemplars within the range statements. However in the conceptualization of the Natural Sciences the document does state that: '*scope statements for the respective themes suggest more particular interests as well as contexts and concept areas; imply links to other learning areas; and imply cross-curricular links*' (NS-6). It is the expectation that integration of this level would happen when phase organizers (organizing themes applied across learning areas) are decided upon by schools. Policy writer B-C2005 reflects on integration at this level and alludes to the devolution of the curriculum:

> *With the four themes we were easily able to integrate with other LA s e.g., naturally formed materials and man made materials. Milk is a naturally formed material and butter a man made material. These two instances is very much tied into technology but I think we were particularly clever in doing that, the themes were fairly easy because they divided across the likes of life, physics, chemistry and that satisfied people and then what we did was we had our sub-themes and the idea was that the across the sub-themes it would be at that level that we would cross the boundaries between life and living, energy and change and we took some of the life and living sub-themes and you linked it with the energy and change sub-themes you would then start talking about the energy relationships within an ecological system then that at least gave us the framework within which to select content, we did not envisage that the content would be determined by a rigid syllabus. I think the majority of people in that committee did not want to go back to the old, rigid syllabus where teachers were tied precisely. The problem is that most teachers in this country need a syllabus, otherwise they are left high and dry, they can't teach anything. Our idea, perhaps idealistically was that the creation of content would be left to textbook writers, to publishers, to teachers themselves, teacher groupings and science associations. They could produce materials, we wanted to cut it free from the old syllabus because we thought that*

this would produce exciting new materials that would get kids excited about science.

This results in further demand on teachers, in terms of knowledge and time. Implicit in this document is the move by the teacher from a subject specialist to a generic educator. Given that the vast majority of South African teachers are under-qualified or unqualified in their own specialist areas, and the absence of teacher support for the new curriculum, the likelihood of integration occurring at any substantial level is minimal. Teachers that are most likely to succeed at implementing the new curriculum and make substantial input in its development are those from well resourced, priviledged schools. Christie (1999) points out that:

> The sophistication of the policies brings the unintended effect that they are likely to be of most benefit to those communities and schools that have resources to take advantage of the opportunities they offer. For under-resourced communities and schools, these policies may produce the opposite effect, acting as extra burdens rather than opportunities for improvement (p.282)

Policy writer B-C2005 alludes to the problems of implementation. Christie (1999) adds:

> These policy frameworks have given almost no attention to the context of implementation and how the new vision could be put in place in the profoundly unequal school contexts that apartheid has left behind. This approach has implicitly assumed that the formulation of policy can be logically separated from its implementation (p281).

Many have argued that C2005 did not sufficiently acknowledge the extreme inequalities created under apartheid:

> What is being foreclosed in the consensual language of OBE are the more complex manifestations of difference and inequality, therefore, of equality and equity. Omitted in the discourse of OBE is a deliberate awareness of the very divides and fractures which have specified the public face of South Africa (Baxen and Soudien, 1999:141)

This view is also emphasized by Policy writer I-RNCS:

> *You know you are given a framework to do that but whether it will bring about systemic change, I'm doubtful. It doesn't work like that in the real world of the classroom. But its needed and I understand on the curriculum level you need a policy and it's a nice policy framework but whether that influences practice I would argue its again, it refuses to take reality as the starting point. If you understand the reality of the classroom, the reality of the post apartheid education system, that's the product of apartheid. We reap what we sow you know, and we were sowing in our past in terms of apartheid. You can't wish it away; you can't make it a new crop and pretend another crop is growing there when it is not. So given the idea of curriculum approach that we don't ......I*

would much rather the starting would be watching what works and what doesn't (Policy writer I-RNCS).

Chisholm (2000) argues that the designers of C2005, in an attempt to counteract the rigidities of the old subject based curriculum, have given too much attention to integration at the expense of conceptual coherence. The report cites this as a particular problem for fields of knowledge where attention to progression is structurally important, namely in languages, sciences and mathematics. This is the swing back to high knowledge, high skills, more than a criticism of integration as such. Teachers were putting too much energy into (poorly designed) cross-LA linkage, and not enough into vertical development of the learning area.

In the RNCS for the Natural Sciences the document states that: *30% of the time should be used to extend these minimum knowledge statements; alternatively, science content from contexts which are significant to the learners and local community may be used. These contexts may be economic, environmental, social or health matters, for example (RNCS-61).* There is a clear articulation of integrating science knowledge with the context of learners' lives. There is also an articulation of thematic links within the science discipline throughout the document. There is a marked shift in the integration of learning areas from the C2005 policy document. This links closely with the regulative discourse of the kind of teacher that is envisaged by the RNCS: *...teachers who are qualified, competent, dedicated and caring. They will be able to fulfill the various roles outlined in the Norms and Standards for Educators. These include being mediators of learning, interpreters and designers of Learning Programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors and Learning area or Phase specialists (RNCS-3).*

The discourse of the policy document places the learner at the center of learning and teaching. Constant reference is made about what learners need to do, and know e.g., *learners need to know that science is a human activity* .....(NS-5). This is also evident in the opening line of the assessment criteria, range statement and performance indicators for each specific outcome (NS-9). The rationale for the learning area clearly states that: '*learners should be active participants in the learning process in order to build a meaningful understanding of concepts which they can apply in their lives*' (NS-5).

A learner- centered pedagogy places philosophical demands on both teachers and learners. It shifts the authority relations in the classroom and could manifest itself in unproductive ways and could on the other hand create possibilities in the classroom: *the outcomes encourage a learner-centered and activity-based approach to education.* They leave considerable room for creativity and innovation on the part of teachers in interpreting what and how to teach. In other words, learner-centered is meant to guide not only how to teach, but what to teach.

In the selection of conceptual knowledge for the C2005 process, no-one in the interviews questioned the basis in Physics, Chemistry and Biology: the changes in content that they anticipated were Earth Science, applications of science, fuller discussions of the nature of science and some [undefined] notion of African science. Policy writer E-C2005 makes oblique mentions of vocational education, also undefined. Beyond that, their concerns were largely about purposes, and pedagogy: context-based learning, problem-based learning, constructivism. In other words, their 'updating' was more about purposes (broad social purposes, detailed learning purposes) and curriculum design than curriculum content (perhaps this is fair: lots of different content can be used to suit any chosen purpose, and perhaps, at school level, changes in the social understanding of science, certainly at the regulative discourse stage, are more important than changes in the detailed content). The writing team was free to choose content – while they might have anticipated pressures from environmentalists, feminists, Africanists, industrialists, academics etc., there were no organized lobbies, meetings, or submissions, it is clear that the conceptual knowledge that is selected is based on these professionals as 'experts' choosing the content that will treat the social problem. Policy writers agree that certain concepts and content areas are key to defining science and these concept areas can be developed using both local and global contexts. There is an agreement that the local and familiar are used as vehicles for teaching and learning but that science is grounded in a core body of knowledge/concept that every learner should know.

As a policy statement, the preamble to the C2005 policy document makes explicit that the Natural Science Learning Area is committed to: '*challenging the perception that Science is predominantly a European discipline*'(NS-2). There is reference to alternate forms of knowing: '*....science cannot necessarily be seen as the only way of making sense of the world around us. Other cultural means of clarifying the world, such as through language, religion or art, should be seen as a validity and benefit, just as science has*'NS-19). The document acknowledges others ways of knowing but the methods of exploring them and dealing with conflicting knowledge systems is left to supporting documents and classroom teachers. In Appendix B, limited examples of the conceptual knowledge supporting this statement is presented (see SO6).

The RNCS policy document contains an entire chapter devoted to conceptual knowledge titled: *Chapter 5: Core Knowledge and Concepts* (RNCS-p61). A content analysis of the various conceptual areas per phase is presented in Appendix D. Selection of content was highly influenced by overseas trends and the 'road map' guiding the writing of the policy document, calling for a 'high skills', 'high knowledge' curriculum. This is in response to the 'content free' curriculum, where selection of content was left to classroom teachers who did not have the skills or guidelines to do so (i.e., devolution of curriculum design). Appendix D contains the 70% core conceptual knowledge that should be covered for the GET phase. Clear indications are given on the kinds of conceptual knowledge for each of the four broad themes: Matter and Materials, Life and Living, Energy and Change, and Planet Earth and Beyond. The Africanisation of conceptual knowledge was left to the domain of classroom practice where the document states that:

> *The knowledge statements for the Intermediate and Senior Phases represent a notional 70% of the time in a Phase's Learning Programme. The other 30% of the time should be used to extend the minimum knowledge statement, alternatively, science content from contexts which are significant to the learners and the local community may be used. The contexts may be economic, environmental, social, or health matters, for example (RNCS-61).*

This statement makes oblique reference to indigenous knowledge but how the teacher would explore the underlying structures of these knowledge systems is not made explicit. The concept of indigenous knowledge is explored to some extent in the assessment standards: *understands science as a human endeavour: Recognises differences in explanations offered by the Natural Science Learning Area and other systems of explanation (RNCS-59) and understand science and technology in the context of history and indigenous knowledge (RNCS-p20).* In the main knowledge is localized or learned in context rather than redefined. This places tremendous demands on teachers both in terms of their philosophical orientations and conceptual demands of indigenous knowledge. For the under and un-qualified teachers the problem is further exacerbated by resource limitations (see earlier discussion on governmentality). The policy writers do concede that direct advice is omitted because they don't know how to build it in: that the policy in this sense is an invitation to research and development:

> *Now the whole question of indigenous knowledge, what is indigenous knowledge came up several times and at out committee level, at the task team level, at the MPC level, we debated what indigenous knowledge is. We are saying what happens to indigenous knowledge in KZN, is it indigenous knowledge for Western Cape that is the huge question we are faced therefore we said if we write in content for indigenous knowledge how do we write it. There is the difficulty we are faced with right and of course the bulk of indigenous knowledge is not in written form. We have indigenous knowledge, what written documentation there is, is lacking. You got people, the older people, your songoma who have a wealth of information on indigenous knowledge so we find the indigenous knowledge section is not written in. That's another reason we had the 70/30%. The reason being: (1) what is indigenous in KZN may not be indigenous for Limpopo and (2) is the fact that if you write in indigenous knowledge, our knowledge base, what we actually know about indigenous knowledge is only based on what has been documented, and that is precious little. And the moment we write it in we are limiting* (Policy writer N- RNCS).

I have attempted to explore here, the extent to which the selection of conceptual knowledge in the policy documents have excluded a vast majority of the population from engaging with this knowledge and the policy intentions of including this problem group (for e.g., in terms of leaving 30% of the knowledge to be developed from context) is impeded by the disparities evident in classrooms and schools. I have not explored the structure of the discipline (in this case Natural Science) as this analysis falls outside the focus of my study.

In both the C2005 and the RNCS common outcomes have been stated for all learners as one way of achieving social justice. Willis & Johnston (1998) argue that this implies uncommon curricula:

> In Western Australia, social justice principles are central, at least in the rhetoric that surrounds this curriculum policy change. The argument is that a commitment to ensuring that all students have access to, and succeed with, high quality outcomes will enhance equity; that there is considerable social justice potential in the clear articulation of 'what's important' together with the assumption that all groups of students, regardless of their class, gender, race, ethnicity, physical ability, and so on, should achieve at high levels with respect to a common set of outcomes. This involves the premise that all students can achieve learning outcomes of significance so long as the condition necessary for their success are met, and that it is the responsibility of schools and systems to ensure that those conditions are met. This may, of course, require that schools vary curriculum, learning conditions and time (Willis and Johnson, 1998:125).

In order for common outcomes to achieve their redress potential the curriculum needs to respond to students in different ways:

> A curriculum that enables all students to learn must allow for different starting points and pathways to learning so that students are not left out or left behind; allow for different strategies and approaches that meet varying learning styles and needs; allow for the reality that different areas of study are differentially relevant (and will be differently pursued) in various communities because of geographic, economic, topological, and cultural considerations and allow for the prospect that students demonstration of their knowledge which is grounded in these contextual differences (Darling-Hammond, 1994:489).

Differential outcomes encourage differential expectations and streaming which together perpetuates and exacerbate inequalities (Wiggins, 1991), that 'what you accept is what you expect' and that the 'the futures of many students are compromised because the outcomes held for them are low or unclear....some schools and some students are held to high standards while others are not' (O'Niel, 1994:8). Willis and Johnson (1998) state that defining the same outcome for all is particularly important for those students who traditionally have not been well served by schools. Systems and schools should be held accountable for ensuring that the conditions necessary for student success exist in all schools. Proponents of common outcomes do not claim that all students are alike or equally academically skilled rather they argue that all students have a right to engage in a curriculum which offers high quality intellectual tasks, all should be expected to produce high quality work and, with a few exceptions, held to high standards. Clearly what is required is for schools and systems to deliver this high quality curriculum. In South African schools it is doubtful whether most schools can produce the conditions necessary for students' success. Darling-Hammond captures this in the context of school restructuring:

> The foundation of genuine accountability- one of the most frequently used words in the school reform lexicon- is the capacity of individual schools: 1) to organize themselves to prevent students falling from the cracks, 2) to create means of continual collegial inquiry (in which hard questions are posed regarding what needs to change in order for individuals to succeed), and 3) to use authority responsibily to make the changes necessary. (Darling- Hammond, 1993: 760).

What is reflected in the policy documents is a move away from 'illegitimate categories of discussion' as this would not forward the goals of social justice. These conflicts were the focus on earlier discussions on curriculum, for e.g., at NEPI:

> Understandably, the policy work on education has taken as a starting point a democratic framework that is driven by the language of redress, access, and affirmation. The starkness of the apartheid statistics on exclusion and failure translates readily into a discourse of inclusion and openness that cannot easily accommodate traditional criteria and conventions of selection and excellence. Selectivity and excellence were traditions so intimately entwined with discrimination as to find themselves now almost illegitimate categories of discussion (King, 1993).

8.3 Summary

The RNCS clearly states that it seeks to promote human rights, social and environmental justice. All newly developed Subject Statements are infused with the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. In particular, the RNCS is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors. The RNCS adopts an inclusive approach by specifying minimum requirements for all learners (Roadmap document). A regulative discourse of dispositions, attitudes and values is embedded in the instructional discourse of the discipline. This is clearly the case of the Natural Sciences. It terms of policy intentions alone, social justice will best be served by a strong instructional discourse, which the Natural Science statements have done to some extent - how this is realized in the classroom is crucial. The revised statements acknowledge that all learners should be able to develop to their full potential provided they receive the necessary support. The intellectual, social, emotional, spiritual and physical needs of learners will be addressed through the design and development of appropriate learning programmes and through the use of appropriate assessment instruments.

Chapter 9

Policy Lessons and Recommendations

> *If we were very honest with ourselves about what we know about education, one of the few things that we actually do know for certain is that there will be conflict over the curriculum. Because "official knowledge" is always a selection from a much wider universe of possible knowledge, and because such a selective tradition is often connected to deeply held social and ideological commitments, what is legitimate for one sector of society is often illegitimate for another* (Apple, 2003).

9.1 Introduction

In this chapter I pool together the different levels of analysis and reflections on policy methodology in an attempt to draw out policy lessons in an emerged democracy. Given my theoretical stance, I make no attempt to provide a causal relationship between what happened in the policy domain and what panned out in the policy documents. I will instead draw on the various theoretical leanings to propose policy lessons.

9.2 Policy Lessons

9.2.1 An 'ideal' that makes intellectual sense but does not fit conditions in society can exacerbate the problems it seeks to solve.

Social melliorists believe that education could be used as an instrument for social progress. They want in some way to mediate social evils that create inequality. Melliorists attempt to curb inequality and raise social consciousness. In an attempt to be all things to everyone, policy easily risks falling into the trap of social melliorism, where the commitment to a vision of *what should be* clouds the ability to consider *what is* so that the good intentions of social reconstructionism have more influence on the policy agenda than social and school realities (see Westbury, 1973; Goodson, 1991; Kliebard, 1987). This has been the case with South African education policy and curriculum policy in the case of this particular study. This agenda has been widely criticized and has given credence to Jansen's (1999) point that 'it is important to understand the origins and anticipated trajectory of OBE (and indeed other curriculum reforms) as primarily a political response to apartheid schooling rather than one which is concerned with the modalities of change at the classroom level' (p145). In an attempt to redress past injustices and inequalities, the exuberance of policy intentions is littered with symbolism and a lack of considerations of conditions on the ground e.g., poor teacher training, under-qualified and unqualified teachers, few resources etc. In Christie's (1999) view ' better resourced, historically privileged schools are more likely to be able to manage the new policies than historically disadvantaged, mainly black schools, and particularly the poor, rural and marginalized among them' (p290). As importantly the imported discourse of globalization assumes a degree of stability and modernization that simply does not exist in South African schools. Baxen and Soudien (1999) argue in relation to OBE that policy attempts to construct 'a universal subject with universally good attributes" (p138) without addressing the social history of these attributes. In their analysis, the construction of the universal subject is:

> abstracted from the social conditions of poverty, continued racial oppression and pedagogic neglect; and is also abstracted from the specificity of the cultural orbit of South Africa, as Manganyi (1991) has argued, young people are having to learn how to navigate their way through the competing ontologies and epistemologies of white and middle- class world and an African and often working-class township or rural location (139).

Critical policy analysis highlights the messiness of the policy process and projects policy as frequently comprising symbolic gestures and pseudo-scientific rationality that have little meaning beyond the immediate sound bite. The white-toothed discourse of smiling media savvy advocates may be seen as little more than a conviction that asserting a desired reality makes the reality unfold (Lewin et al, 2003). Some policy writers in this study have acknowledged that they see policy as a politically led process that ignores the 'conditions on the ground' and is blind to unpalatable facts. An extreme view is that policies are never intended to be implemented, because their gaze is fixed not on system-wide change, but short-term political expediency.

Lewin et al (2003) argue that:

> Policy (and possibly planning) takes place on the basis of what ought to be true, not what is true. A gloss on the contradictions this can create is that policy formation is seen as essentially multi-vocal in ways which aim to satisfy a very diverse set of stakeholders who share paradigmatically oppositional views of teacher education reform and transformation. Policy can become "anything

to everyone" with few practical consequences that challenge orthodoxies or weight expertise and insight. The politics of compromise that exaggerated forms of stakeholder participation, where all voices are given equal significance, can lead to inchoate outcomes with little chance of being implemented (403).

The Chisholm Review found that implementation ran into a multitude of difficulties. It found that the implementation of C2005 was compromised by the complex structure (coherence and details were not clear) and design of the curriculum, tight time frames, lack of resources, a weak model of teacher training, insufficient learning support materials and poor departmental support to teachers. (Chisholm, 2000: 27). Participants in my study too had noted that, for the C2005 process, teachers at classroom level were expected to pick up the pieces resulting from a lack of consideration of implementation realities:

And what was really, really learned at ground level for teachers, how on earth are they going to get this whole approach which was very visionary, very vague, very new, completely devoid of a framework, how do you get people involved in the new curriculum. So I think the whole thing floundered at that point (Policy writer F-C2005).

The process was driven by an overwhelming intention to bring about some change:

My own view was that we needed a new curriculum, even if we were going to fail, we needed to dive into and make enough waves for people to realize that change is going to happen and change must happen....... (Policy writer B-C2005).

In addition, the general perception amongst policy writers was that the majority of teachers would not be able to interpret the policy documents, that the policy document privileges teachers who are specialists in the discourse of the discipline:

So on the one hand its important to say that teachers can interpret the policy document on the other hand its important not to live by that expectation. People may read the policy guidelines and have certain expectations and ideals, for INSET, people that develop assessment and certainly for the commercial publishers. Some of them go around and find the very best people they can to write and interpret the document and that overwhelmingly in all education systems. That is the way the curriculum gets to schools (Policy writer E-on the RNCS).

The benchmark has been set, but the reality of achieving its regulative goals of social justice, equity and redress without structures in place appears bleak:

So yes the bar has been set very high with the expectation that the implementation is going to be realistic and the people are going to be helped to achieve basically a very high standard with the science curriculum (Policy writer O-RNCS)

9.2.2 'Change is only as effective as the smallest unit': in the policymaking arena the smallest unit is the policy writers, in the arena of practice it is the classroom teacher.

The policy process occurs in domains with varying levels of contestation within and between domains. These contestations influence the policy: different people, different groups, different structures would lead to different policies. The policy construction process is not linear; it is recursive as conflicting interests and motivations spiral through different contexts and domains. One classification of domains defines a global domain, macro domain, meso domain and micro domain. The global domain involves world politics, activities of multinational corporations and global agencies, including global trends in educational management (such as outcomes-based approaches) and the goals of science education. The macro domain of policy making involves the nation state and those groups and agencies that comprise that level. The meso domain includes the system e.g., education, whilst the micro domain of policy making may involve individuals, organizations, institutions or groups at local level. Within each of these domains struggles and tensions are played out between stakeholders and interest groups. At the same time there are intra-domain tensions and struggles occurring as well as inter-domain tensions and struggles. Within the micro domain of policy making (where this particular study is located) there are various sub-levels of operation, from the management of the process to the writing process. Thus the policy that emerges in any one of these domains is the outcome of intra and inter domain tensions and well as the tensions in the sub-levels of any particular domain (both intra and inter) and one domain cannot be seen in isolation from the other domains. There is a constant and dynamic interrelationship between the domains.

Struggles - or contested terrain (Ozga, 2000) – will be evident in each domain, contributing to the 'messy realities' (Ball, 1994) of the policy process. Influences feed into the policy text production at each level. Taylor (1997) suggests examining how these contexts continually relate to each other. For example, possible avenues and mechanisms for feedback from micro level influence texts, practices/effects, outcomes and political strategies which contribute to the reconstruction of policy text at the macro level. The balance between macro constraint and micro agency would be expected to vary with different policies, but it is important to consider both. The concept of 'policy networks' may be one way to bridge the gap between top-down and bottom-up views of the policy process. Raab (1994:13) has defined policy networks as "a generic label for different types of relationships between the state and interest groups in the policy process" which highlights the interconnections between the state and other actors. Notwithstanding these various levels of contestation the outcome of the final policy is dependent on the writers of the policy: their articulation of change is the written policy documents.

This study shows evidence of this. In Chapter 6 details of the structure of the policy making process were presented. In the C2005 process the rational model of curriculum development envisaged by the national Department of Education could not be even approximated: limitations of resources, time and processes meant that the process was weighed down by practical realities of coping with various interest groups in their effort to embody a broad stakeholder forum. Participation in the policy process was confined to certain stakeholder groups e.g., the extent to which learners and parents were consulted is unclear. Moreover in a large policy area with numerous institutions, nine provincial departments, unions, NGO's and particular interest groups, the representation and meaningful participation of stakeholders was structurally limited. Curriculum development also suffered at the hands of political necessity to deliver. The pace and nature of work did not allow stakeholders meaningful and full participation in the process.

Unlike the C2005 process the RNCS process has been characterized as expert driven. The management of the process drew on the C2005 experience and formally advertised posts for the RNCS process. The 'experts' were selected through a formal process. Whereas the process of designing the first version of Curriculum 2005 attempted representation in terms of stakeholder involvement, its revised version was representative in terms of individual expertise and experience: departments of education; race and gender participants; and stakeholder representation in a small Reference Group. The number of individuals involved in conceptualizing and writing the document was limited to ten. This process also included two mentors that were also part of the management team (MPC). Although the Department claims that this process was 'expert driven' Policy writer E- on the RNCS claims otherwise:

> .... *C2005 was described as a stakeholder driven process while the NCS was described as an expert driven process. And I don't think either of those was really true* (Policy writer E-on the RNCS).

Unlike the C2005 process, in the development of the RNCS there were structures in place to collate the responses from the public input by interested stakeholders. These responses were constructively used in writing the final policy document.

The policy writers for both the C2005 and the RNCS processes were the shapers of the policy documents, despite rationalities of the government. Rationalities of the government provided the structures and frameworks at the macro and meso levels but at the micro level policy writers had great freedom and were limited more by time constraints than external pressures. The covert but major influence was from the professionalisation of the writers as science educators who knew South not only African science education but also international research and documents.

The writers were also swept along by the currents of change surrounding them – currents that swirled and intersected, but nevertheless had a clear direction. Notwithstanding the national debates that led to the government's decision to adopt outcomes-based education as the basis of the NQF (Jansen, 1998), there was little contestation on the transformation agenda.

> *The kind of global movement towards outcomes based education in various forms and you know the transformation that was happening in the country it was like a whole lot of things coming together and gaining momentum that might drive it through* (Policy writer D: C2005).

The wave of transformation and its agenda found public acceptance, and policy writers readily adopted the principles of learner-centered, outcomes-based education and integrated knowledge. This acceptance was in large part because of the 'kind of global movement towards outcomes based education'. Science policy makers were well aware of the other trends in overseas science education reforms of the time (i.e., shifting to context based learning, thematic approach to concepts, inclusion of environmental and earth sciences conceptual knowledge, linking theory to practical and teaching underpinned by the broad base notion of constructivism, etc) and wanted to 'catch up' with these trends:

> *I think it was long overdue, the turnover time for curriculum revision prior to 1994 was supposed to be about five years, in reality it was a helluva long time. General science had just been reviewed neither physical science nor biology had gone through. So we were then dealing with and still are as far as I know dealing with the 1984 syllabus. Now for a science to be twenty years behind what is happening (Policy writer D: C2005).*

What is clear though (see Chapter 5) is that there were many issues that needed to be addressed in the design of the curriculum, underpinned by the broad ideology of curriculum development at the macro level of policy making (i.e., learner centeredness, outcomes based and integration). These are, amongst others, the need to broaden the focus of science conceptual knowledge, skills, purposes, to include values and ethical considerations to science development, to recognize workplace learning, to align science education with current internal thinking e.g., underpinned by constructivism, learner centered education, integration of conceptual knowledge across, and within disciplines and a building of a twenty first century economy that would be globally competitive. Whilst the Natural Science working group was not characterized by much political and practical tensions, moods and forces outside the group impacted on the group in an attempt to conform to a particular model of policymaking.

A major aim of the RNCS, as in C2005, was to promote 'democratic values' and to prioritize 'justice and social citizenship'. The reform process was not just about reforming 'content' – it was about unifying curriculum into a single 'national curriculum' (hence breaking the racist/geographic basis of the old syllabi) and at the same time promoting localization and breaking down 'privilege'. The solution was a national framework of outcomes (as broad competencies) and principles of learner-centeredness, outcomes based and integration of knowledge but with devolution of curriculum design and the writing of learning programmes. In reforming the science curriculum there was limited influence from the science community driving the process – we have the 'science discourse' brought into the 'education discourse' by science educators much more than scientists. It is also interesting that the Science team took pride in standing somewhat at distance from the writing teams in other learning areas – in C2005, they managed to insert 'content'; in RNCS they made a number of new rules, such as the 70-30 rule in specifying content. However the RNCS is much like overseas in the way the four themes were chosen and the way in which assessment standards were written etc, and that the dominant view of 'equity' was access to 'world standard curriculum' (taught in local contexts)'.

The vision of C2005, maintained in the RNCS, was of teachers as curriculum designers, using local contexts and resources to express the centrally defined outcomes and principles.... Thus the responsibilities for achievement of the policy-vision were passed to teachers.... In the arena of practice, it is the classroom teacher that can bring about effective change.

9.2.3 Timing determines what is possible: the socio-political climate of 1994 resulted in some important silences- especially from conservatives and scientists.

I have discussed above the ways in which the timing of the policy developments – coinciding as they did with the peaceful transformation of South Africa to democracy and the attendant political and personal freedoms – provided an extraordinary opportunity for radical and creative policy development. But while the policy process allowed some new voices to rise, others fell silent, and many were simply too far away to be heard. Occurring in all domains of policy making is another crucial element of the policy making process: that of voices that are not heard or not raised. In the case of the former, this is about what language is privileged and becomes the discourse of policy that creates permissions and prohibitions about what is acceptable and what is not at any given time in any system. Deetz (1998), in discussing voice in relation to Foucault's work claims:

Voice can be considered as an attempt to open discussion about issues that apparently need no discussion and to act *on* rather than simply *in* present institutional arrangements. Voice, thus is the presence of active resistance to consent processes. 'Voicing' opens both the corporation and individual to learning through reclaiming differences and conflicts overlooked or suppressed by dominant conceptions and arrangements. All discursive formations centralize particular concerns and interests and marginalize others. Dominant arrangements normalize people and events along the lines of certain interests. Voices reclaim that which was marginalized, putting it back into competitive relation with the dominant interests. (p159)

Recent theoretical movements, like post-structuralism has highlighted the development of the concept of 'other'. Previously silent voices are now being heard resulting in the emergence of new social discourses. At the time of the first democratic election it was politically correct to listen to the voices of those who had been marginalized by apartheid. These voices were co-opted into the current policy discourse. Co-option as a political tool by the government is an effective mechanism to silence the voices of discontent with a promise of power, status and recognition (Unterhalter, 1998). As this study (see Chapter 7) and other studies (Morrow, 1998; Unterhalter, 1998) has shown, the long history of racial discrimination, and later apartheid policies which systematically excluded non-whites from policy structures and processes, has led to a strong desire in the democratic movement to create more inclusive and transparent policy processes but this did not pan out, as indicated earlier (see Chapter 5) by policy writer E- C2005, there were no structures in place to involve a broad consultative process as possible. Consequently, the few that had the expertise and capacity drove the process, leaving minimal change in the social order:

we used to have big arguments about the difference between representation and participation and they made every attempt to make it representative but they didn't encourage participation, real participation. So there were times when it was very democratic and there were times when it wasn't. (Policy writer C-C2005)

This similarly reflects the NEPI experience that was perpetuated in the curriculum development processes:

Each brought his/her individual experiences, insights and expectations to bear on the discussion of policy research processes and the functioning of the group. Upon reflection it was evident that although a good working relationship was fostered, it camouflaged a range of contradictions and ambiguities underlying much of the interaction. Implicit assumptions and expectations in the group pressurized the more skilled and experienced white researchers to take on the more complex tasks. The Black researchers in the group volunteered for less complex tasks that utilized their skills and which they felt more confident in performing. The ability and confidence required to articulate ideas, challenge proposals or even edit work reflected inequalities in members exposure

> to research, experience in writing and experience in collective work. These inequalities were masked in the group, as a conscious effort was made to uphold democratic practices and encourage participation of all members. The inequalities largely reflected the present country-wide concentration of research skills, experience and confidence among the more experienced and confident researchers. By not recognizing this and consciously debating this issue we created a situation of false equality. Since we were not sufficiently confident to take on new roles and tasks, we reinforced these inequalities (Ganie and Prinsloo, 1993: 217).

Silences in this case can be a potentially dis-empowering act. Silences can be manipulated and contrived in social contexts by other players and stakeholders. This raises questions about the sincerity and social acceptance of the 'other'. Eagleton (1996) claims that:

> Like any other theory, post-colonial discourse has its limits and blindspots. It has sometimes involved romantic idealization of the 'other' along with simplistic politics which regards the reduction of the 'other' to the 'same' as the root of all political evil. This particular postmodern theme of otherness and self identity, is by now itself threatening to become drearily self-identical.....Some theory has been genuinely pathbreaking, while some of it has done little more than reflect the guilty self-loathing of a Western liberalism which would rather, in these hard times, be absolutely anything but itself (205-206).

The very nature of the policy process (limited time frames, ad-hoc structure, practicality, etc) has excluded the 'marginalized other' from the policy writing process (see Chapter 6). Furthermore, the voices that are silenced in policy making may be those whose cause is not sufficiently 'trendy' to be taken up publicly, or who do not have the resources to mount a campaign or form a new social movement. This is reflected by the comment made by policy writer A-C2005:

> *But another thing you must understand: the terrain of struggle was different. You get terrains of struggle in the streets where the power of the mass counts, then you have terrains of struggle which are intellectual, where you got a committee of ten people who are brought together to do something where, in that kind of forum, the numbers don't count, the muscular strength doesn't count. What counts is your intellectual strength.*

Such voices may be those who are in the lower socio-economic strata of society, those whose language and literacy skills are not recognized by elite society, those whose sense of self is low or under-developed (Ling, 2003), and those who live in poverty, far from newspapers and email and consultative meetings. This is particularly significant in the curriculum reform period that South Africa has undergone. King (1993) highlights the tension between excellence and discrimination that the ills of apartheid had created:

> Understandably, the policy work on education has taken as a starting point a democratic framework that is driven by the language of redress, access, and affirmation. The starkness of the apartheid statistics on exclusion and failure translates readily into a discourse of inclusion and openness that cannot easily accommodate traditional criteria and conventions of selection and excellence. Selectivity and excellence were traditions so intimately entwined with discrimination as to find themselves now almost illegitimate categories of discussion (199).

Other dimensions of the 'silent voice' is the absence of a scientific community that have resources but did not aggressively contest the content of policy as they did in countries such as the case internationally. There did not appear to be a strong push from the scientists and science academics to bring in certain kinds of content at the GET phase. As Policy writer D reflected:

> *Traditionally when you talk about a curriculum for schools the professors will say well what do we want the learners to know when they come to us. That might have been that kind of thinking certainly when we talk about grade 1 to 9 scientific literacy its not about preparing for first year physics. We did take into account the needs of the learner and of the society, we narrowly perceived as academics we are interested in getting students at the university which says nothing about what that student should be learning and what their concerns should be and certainly we didn't do that, but on the other hand yes we were many from the academics were involved in designing it and you mustn't go with the idea that their interests were to bring in certain content (*Policy writer D-C2005*).*

Human voices who exercise choices to act or not to act make a difference to the systems within which they exist (Ling, 2003). If silences were voices, the policy process would take a different course. Thus policy is much about who is excluded or exclude themselves, as who is included in the process. Policy is the product of sounds, silences, conflict and struggles (Ling, 2003).

9.2.4 In the science policy documents the definition of scientific literacy is epistemological at two levels: the idea that scientific literacy can be defined and constitutes individual knowledge, and the view of knowledge in the policy.

Scholarly discussion of scientific literacy is often based on three unstated assumptions: scientific literacy is an attribute of individuals, science is the paradigmatic mode for rational human conduct, and school knowledge is transportable to life after school (Lee and Roth, 2001). Although the debate about scientific literacy has long been ongoing (see

Chapter 2), there remains at least one fundamental assumption that has not been questioned: scientific literacy is the property of individuals and can be measured by means of traditional forms of individual assessment. Thus, the debate over scientific literacy focuses on knowledge, facts and theories that individuals are expected to exhibit. This is also the case in both the C2005 and the RNCS policy documents (although the C2005 document makes an oblique reference to working in groups). In the everyday world of the community, science is known and valued especially through technologies. As knowledge, it emerges not as a coherent, objective and unproblematic body of knowledge and practices but as uncertain and contentious, unable to answer important questions pertaining to the specific (local) issues at hand (Jenkins, 1999). In everyday situations citizen thinking may offer a more comprehensive and effective basis for action than scientific thinking (Lee and Roth, 2001). They propose thinking about scientific literacy in terms of 'citizen science', which is 'a form of science that relates in reflexive ways to the concerns, interests and activities of citizens as they go about their everyday business' (Jenkins, 1999, p.704). In the research undertaken by Lee and Roth, citizen science was related to a variety of contexts, ranging from personal matters (e.g., accessibility to safe drinking water), livelihood (e.g., best farming practices), leisure (e.g., gardening in sustainable, organic ways), to activism or organized protest (e.g., Lee and Roth, in press).

In contrast to the current ideology of scientific literacy as a property of individuals, Lee and Roth propose scientific literacy as a characteristic of certain everyday situations in which citizen science occurs. This implies that science educators no longer seek to stack educational environments to coax individuals into certain performances, but they would set up situations that allow a variety of participatory modes, more consistent with a democratic approach in which people make decisions about their own lives and interests. Science and scientific literacy constitutes the outcome of a lived curriculum. Conceptualising scientific literacy in this way furthers the ends of a social justice agenda. Lee and Roth (in press) use the analogy of fibers and threads- a collective activity is analogous to the thread and individual contributions are no more than the individual fibers to conceptualise scientific literacy. Scientific literacy can be thought of as something occurring in a group rather than as a property of individuals. They extend their analogy of fibers and threads in another way: in everyday collective endeavors over contentious issues, science is but a fiber amongst many other fibers such as politics, economics, aesthetics, sociology, philosophy, or everyday know-how. This view of scientific literacy has implications for assessment as well. Large scale standardized tests/ exams that are targeted at accountability of the system begs for the definition of science as a property of an individual. At the level of praxis, at least, redefining scientific literacy as a collective property has value for the meaningfulness and relevance of the curriculum.

At the second level of epistemology, is that scientific literacy can be defined and the view of knowledge (that one acquires to become scientific literate) in the policy documents. A view of knowledge as an entity (that it exists as object, free from its sources and uses) presupposes that this knowledge can be defined. In the same way, a universal conception of scientific literacy views scientific literacy as an entity that can be defined. The C2005 document explicitly defines scientific literacy (although the definition varies with that of policy writers). The RNCS does not define scientific literacy but suggests ways in which this can be achieved. Scientific literacy as a concept is abstracted and universalized, with the 'contents' of scientific literacy becoming an end in itself. An alternative viewing of knowledge as discourse has immense ramifications for scientific literacy. Knowledge as discourse inexorably contains values, morality and action (Malcolm, 2003, *personal conversation*, 15/10/03). We talk about things in part to try and understand better, or improve our uncertain knowledge. By this definition knowledge cannot be certain. The concept implies that learners will do more with their knowledge than build it into classroom discourse removed from the experiences outside classroom- students are expected to use scientific literacy as part of their lives. By the nature of discourse, scientific literacy is always incomplete and hence emergent.

9.2.5 The policy process and the policy documents challenged hegemony of structure and the epistemology of knowledge.

The concept of hegemony refers to the organizing principle or worldview that is diffused through agencies of ideological control and socialization into every area of human life

(Gramsci, 1957). As such it represents a certain way of life and thought that is not only dominant but dominates. In this sense hegemony advances some communities, diminishes others. The philosophy of the dominant group becomes the official view of the world and is given the appearance of representing the interests of society at large rather than the consciousness of a particular group or a school of thought. Hegemony has worked in many ways to induce the oppressed to accept or consent to their own exploitation and daily misery. For Gramsci (1957) the formation of new intellectual dimensions of thought, inspired by working class experience of oppression is an active possibility, even if risky and difficult.

In Chapter 6, I have alluded to ways in which the science writing team in both the C2005 and the RNCS processes stood apart from the other groups in what finally appeared in the policy documents for e.g., in the insertion of conceptual knowledge in the C2005 policy document despite the brief for a content free curriculum. In the RNCS, the science writing team also introduced the chapter on Core Knowledge in a radical way by specifying that the chapter represents 70% of the compulsory conceptual knowledge with the other 30% of conceptual knowledge to be developed in context or indigenous science. Structurally, there were expressions of challenging hegemony of what the structure should be like. This may as well be a consequence of professionalisation of the policy writers. It arises also from their knowledge that the great majority of South Africans – if not all of them – are influenced by traditional African thought systems, in which reductionism, materialism and objectivism have limited (though important) roles.

There are explicit statements about the knowledge of science that contest the western view of science in the policy documents for both processes. The preamble to the C2005 policy document states that in order for the document to make an effective contribution to education in South Africa the Natural Science Learning Area is committed to: *challenging the perception that science is predominantly a European discipline* (NS-2). Specific outcome seven *(demonstrate an understanding of the changing and contested nature of knowledge in the Natural Science)* is a departure from the traditional conception of science as a body of '*immutable truths and therefore as absolute and without change*' *(NS-20)*. This notion is also reflected in the rationale for the learning area: '*Learners* *need to know that science is a human activity, dependent on assumptions which change over time and over different social settings.' (NS-5).* Also a departure from the Euro-centric conception of science is specific outcome 6 *(demonstrate knowledge and understanding of the relationship between science and culture*) where science is value laden *(*also see specific outcome 8*:'science cannot necessarily be seen as the only way of making sense of the world around us' (NS-19).* At the level of intent, at least, the expression of contesting hegemony was explicit in the document, although some policy writers differed (see Chapter 5 on the contested nature of knowledge) and the contestation was not strong in the choice of conceptual knowledge.

For the RNCS process the expressions of contesting hegemony occurs in the elaboration of outcomes, particularly specific outcome three [*science has roots in African, Arabic, Asian, American and European cultures (*RNCS-p4*); to be accepted as science, certain methods of inquiry are generally used* (RNCS-p4); *knowledge production in science is an ongoing process........new theory replaces dominant view.........knowledge changes over time(*RNCS-p4*); the acknowledgement of the limitations of scientific enquiry (*RNCS_p5*)];* in the preamble to the compulsory content and knowledge chapter [*The core knowledge...........70% of time for the Natural Science Learning Area...........the remainder 30%........around contexts which are significant to learners and local community. These may be environmental, economic, social or health contexts (*RNCS-p7*)]*; and in the assessment standards (*Indigenous or traditional technologies and practices in South Africa were not just ways of working ; they were ways of knowing and thinking (*RNCS- p10*); Assessment Standard: understanding science and technology in the context of history and indigenous knowledge(*RNCS-p20*); It is challenged by those who argue that pure empirical science does not concern itself with the questions of meaning and value , and is therefore too limited a way of understanding the world (*RNCS-p11*); understands science as a human endeavour: Recognises differences in explanations offered by the Natural Science Learning Area and other systems of explanation (*RNCS-59*) and understand science and technology in the context of history and indigenous knowledge (*RNCS-p20*)].*

The blurred distinction between science and technology in the foundation and intermediate phases is yet another case of challenging hegemony. Technology is not seen as an application of science or as a context for science but as separate discipline-elevating its status to that of science. As regards conceptual knowledge there has been no attempt to define and provide conceptual guidance for indigenous science or other ways of knowing in the documents. Policy writers do acknowledge this and view this as an area for research. There is a growing body of literature that recognizes pluralism in ways of knowing. Elkana's (1981) understanding of science argues that every culture has its science and science is "something like its own way of thinking and/or its own worldview" and gives the following definition: "By science, I mean a rational (i.e., purposeful, good, directed) explanation of science of the physical world surrounding man" (p. 1437). Ogawa (1989) asserts that "Western science is only one form of science among the sciences of the world" (p. 248). Also, the people living in an indigenous culture may not recognize their own science, hence, it may be transferred from generation to generation merely by invisible or non-formal settings (Ogawa, 1989).

Indigenous science, sometimes referred to as ethnoscience, has been described as "the study of systems of knowledge developed by a given culture to classify the objects, activities, and events of its given universe" (Hardesty, 1977). Indigenous science interprets how the local world works through a particular cultural perspective. Expressions of science thinking are abundant throughout indigenous agriculture, astronomy, navigation, mathematics, medical practices, engineering, military science, architecture, and ecology (Snively and Corsigilia, 2001). In addition, processes of science that include rational observation of natural events, classification, and problem solving are woven into all aspects of indigenous cultures. It is both remembered sensory information that is usually transmitted orally in descriptive names and in stories where abstract principles are encapsulated in metaphor (Bowers, 1993a, 1993b; Cruikshank, 1981, 1991; Nelson, 1983). Cross-cultural science teachers will need a curriculum that recognizes a community's indigenous knowledge or worldview in a way that creates a need to know Western science (Cobern, 1994; Pomeroy, 1994). As such, a unit of study might include indigenous science content along with western content to explore certain phenomena in-depth. For the South African teacher, with communities that are diverse and multicultural, the challenges and the possibilities are immense.

A possible lead in to the challenge and possibilities is the view of knowledge as **knowledge spaces** because all knowledge systems from no matter what culture or period, have localness in common, many of the small but significant differences between knowledge systems can be explained in terms of the differing kinds of work involved in creating 'assemblages' from the collection of practices, instrumentation, theories and people. Some traditions move it and assemble it through art, ceremony and ritual; science does it through forming disciplinary societies, building instruments, standardising techniques and writing articles (Turnbull, 1997). In both cases, it is a process of knowledge assembly through making connections and negotiating equivalences between the heterogeneous components while simultaneously establishing a social order of trust and authority resulting in a knowledge space. It is on this basis that it is possible to compare and frame knowledge traditions. Such knowledge spaces have a variety of components: people, skills, local knowledge and equipment that are linked by social strategies and technical devices or 'heterogeneous engineering' (Turnbull, 1997).

9.3 Concluding Remarks

Finding a meaningful point of closure is not easy. The largely post structuralist position I adopted in this thesis, opened up a space of uneasiness and unstableness:

> The space opened out and fought over by the words post-modernism, post-structuralism or deconstruction is . . . an unstable and very unclearly bounded territory, crossed and divided in turn by other theories and discourses, which similarly coalesce and fragment in uneasy alliances and disputes over territory . . . So . . . tests that open with definitions, frames and positioning statements disappoint by pre-empitively closing off large areas of space in which they might play Stronach and Maclure (1997: 11).

I have analysed this uneasiness and unstableness via various concepts (governmentality, professionalisation, inclusivity, and ideology) that frame conceptions of scientific literacy. This uneasiness and unstableness works dialectically with easiness and stableness and possibilities. I have attempted to show this through these concepts. In the world of educational practice there comes a moment of closure on policy options but not necessarily on research. That is not to say that policy-making is a tidy and clear-cut business. As Ball (1990, 1994) and others have shown, it is often a messy and confused affair, marked by shifts of emphases, backtracking and redirections. Nevertheless, decisions have to be taken and policy documents have to written. There is, however, an important qualification to be made. While policy-makers have to take decisions within restricted time frames, as far as researchers are concerned there is never a point of final closure. There is always the possibility of going back to first principles, re-analysing the data, incorporating new evidence, applying different interpretative techniques, indeed the very concept of researcher presupposes such intellectual open-mindedness (Humes and Bryce, 2003). Ball (1995: 266) offers a 'post-structural, post-epistemological' alternative. It involves a reinstatement of theory:

> Theory is a vehicle for 'thinking otherwise'; it is a platform for 'outrageous hypotheses' and for 'unleashing criticism'. Theory is destructive, disruptive and violent. It offers a language for challenge, and modes of thought, other than those articulated for us by dominant others. It provides a language of rigour and irony rather than contingency. The purpose of such theory is to de-familiarize present practices and categories, to make them seem less self-evident and necessary, and to open up spaces for invention of new forms of experience.

The post-epistemological theorist will eschew the scientific claim to originality, discovery and the improvement of the human condition (Ball 1995: 268). The educational researcher, on this account, will serve as 'a cultural critic offering perspective rather than truth . . . edifying conversations, rather than truth-generating epistemological efforts must be the staple of a post-structural social science' (Ball 1995: 268). The intellectual and researcher task then opens new possibilities and spaces, and so it becomes:

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.
T.S. Elliot

References

Addison, R.B. (1992). Grounded hermeneutic research. In B.F. Crabtree & W.L. Miller (Eds.), *Doing qualitative research (*pp110-124*)*. Newbury Park, CA: Sage.

Aikenhead, G. S. (1997). Toward a First nations cross-cultural science and technology curriculum. *Science Education, 81*, 217–238.

Aikenhead, G. S. (2000). Renegotiating the culture of school science. In R. Millar, J. Leach and J. Osborne (Eds), *Improving Science Education: The Contribution of Research (*pp. 245–264). Birmingham: Open University Press.

Aikenhead, G.S. & Jegede, O.J. 1999). Cross-cultural Science Education: A Cognitive Explanation of a Cultural Phenomenon. *Journal of Research in Science Teaching,* 36(3), 269–287.

Allchin, D. (1998). Values in Science and in Science Education. In B.J. Fraser & K.G. Tobin (Eds.), *International Handbook of Science Education (*pp. 1083–1092),Vol. 2. Dordrecht: Kluwer Academic Publishers.

Allen, M.N., & Jenson, L. (1990). Hermeneutical inquiry: Meaning and scope. *Western Journal of Nursing Research, 12*, 241-253.

Althusser, L. (1971). *Lenin and Philosophy and Other Essays.* London: NLB.

American Association for the Advancement of Science. (1989). *Science for all Americans: Project 2061.* Washington, DC: AAAS.

American Association for the Advancement of Science. (1990). *The Liberal Art of Science: Agenda for Action.* Washington, DC.

American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy,* Online version: http:// www.project2061.org/tools/ (visited 28 January 2002)

Angeles, P.A. (1981). *Dictionary of Philosophy.* New York: Barnes & Noble Books.

Apple, M. W. (1993). *Official Knowledge.* New York: Routledge.

Atkinson, P.A. (1990). *The ethnographic imagination: Textual constructions of reality.* London: Routledge.

Atkinson, P.A. (1992). *Understanding ethnographic texts.* Newbury Park, CA: Sage.

Bakvis, H. (1997). Advising the Executive. In P.Weller, H. Bakvis & R.A.W. Rhodes (Eds.), *The Hollow Crown: Countervailing Trends in Core Executives* (ch.5). Basingstoke: Macmillan.

Ball, S.J. (1989) Through the Secret Garden and into the Secret Room: political culture and educational policymaking, Paper presented at the conference 'Education Policy and Ethnography', St Hilda's College: Oxford.

Ball, S.J. (1990). *Politics and Policy Making in Education: Explorations in Policy Sociology,* London: Routledge.

Ball, S. J. (1994 a). Researching inside the state: Issues in the interpretation of elite interviews, in D. Halpin and B. Troyna (eds.), *Researching Education Policy: Ethical and Methodological Issues*(pp 107-20). London: Falmer Press.

Ball, S. J. (1994b). *Education Reform: A critical and Post-structural Approach,* Buckingham: Open University Press.

Ball, S. J. (1995). Intellectuals or technicians? The urgent role of theory in educational studies. *British Journal of Educational Studies*, *43*(3), 255-271.

Barthes, R. (1972). *Mythologies.* (A. Lavers. Trans.). New York: Hill and Wang.

Barthes, R. (1975). *The pleasure of the text.* (R. Miller, Trans.). New York: Hill and Wang.

Baxen, J. & Soudien, C. (1999). Outcomes based education: Teacher Identity and the Politics of Participation. In J. Jansen & P. Christie (Eds.) *Changing Curriculum. Studies on Outcomes-based Education in South Africa(pp 131-143).* Cape Town: Juta.

Beeth, M. (2001). Systemic reform in mathematics and science education in Ohio (USA): 1991–2000. In D. Psillos, P. Kariotoglou, V. Tselfes, G. Bisdikian, G. Fassoulopoulos, E. Hatzikraniotis and M. Kallery (Eds.), *Proceedings of the Third International Conference on Science Education Research in the Knowledge Based Society, Vol. 1* (pp. 198–200). Thessaloniki, Greece: Aristotle University of Thessaloniki.

Beeth, M., Duit, R., Prenzel, M., Ostermeier, C., Tytler, R., & Wickman, P. O. (2003). Quality development projects in science education. In D. Psillos, P. Kariotoglou, V. Tselfes,G. Fassoulopoulos, E. Hatzikraniotis & M. Kallery (Eds.). *Science Education research in the knowledge based society*. Dordrecht, The Netherlands: Kluwer Academic Publishers (in press).

Bereiter, C. (1994). Constructivism, Socioculturalism and Popper's World 3. *Educational Researcher,* 23(7), 21–23.

Bowers, C. A. (1993a). *Critical essays on education, modernity, and the recovery of the ecological imperative.* New York: Teachers College Press.

Bowers, C. A. (1993b). *Education, cultural myths, and the ecological crisis.* New York: State University of New York Press.

Brickhouse, N.W., Dagher, Z.R., Letts I.V, W.J., & Shipman, H.L. (2000). Diversity of Students' Views about Evidence, Theory, and the Interface Between Science and Religion in an Astronomy Course. *Journal of Research in Science Teaching, 37*(4), 340–362.

Bybee, R. (1997). Toward an understanding of scientific literacy. In W. Graber & C. Bolte (Eds.), *Scientific literacy* (pp. 37 ± 68). Kiel, Germany: Institute for Science Education (IPN).

Cajete, G. A. (1999). *Igniting the Sparkle: An Indigenous Science Education Model.* Skyand, NC: Kivaki Press.

Carley, M. (1987). *Exploring policy analysis: Rational Techniques in Policy Analysis.* Hampshire: Gower.

Carson, R.N. (1998). Science and the Idea of Liberal Education. In B.J. Fraser & K.G. Tobin (Eds.), *International Handbook of Science Education* (pp. 1001–1014). Vol. 2, Kluwer Academic Publishers, Dordrecht.

Champagne, A. B., & Newell, T. (1992). Directions for research and development: Alternative methods of assessing scientific literacy. *Journal of Research in Science Teaching*, 29(8), 841–860.

Chisholm, L. May 2000. *A South African curriculum for the 21st century.* Report of the Review Committee on Curriculum 2005. Pretoria.

Chisholm, L. & Fuller, B. (1996). Remembering Peoples Education? Shifting Alliances, State Building and South Africa's Narrowing Policy Agenda. *Journal of Education Policy*, 11 (6), 693-716.

Christie, P. (1999) OBE and Unfolding Policy Trajectories: Lessons to be Learned. In J. Jansen, & P. Christie (Eds.), *Changing Curriculum: Studies on Outcomes-based Education in South Africa.* Cape Town : Juta

Christie, P. (1997). Globalisation and the curriculum : Proposals for the integration of education and training. In Kallaway, P., Kruss, G., Fataar, A. & Donn, G. (Eds.), *Education after Apartheid: South African Education in transition.*

Cibulka, J.G. (1994). Policy analysis and the study of education. *Journal of Education Policy* 9, 5-6: 105-25.

Cobb, P. (1994). Where is the Mind? Constructivist and Sociocultural Perspectives on Mathematical Development. *Educational Researcher, 23*(7), 13–20.

Cobern, W. (1994). Point: Belief, understanding, and the teaching of evolution. *Journal of Research in Science Teaching*, *31*, 583–590.

Cobern, W.W. (1996). 'Worldview Theory and Conceptual Change in Science Education', *Science Education, 80*(5), 579–610

Cobern, W.W.(2000). The Nature of Science and the Role of Knowledge and Belief. *Science & Education, 9*(3), 219–246.

Cobern, W. W., & Loving, C. C. (2001). Defining "science" in a multicultural world: Implications for science education. *Science Education*, 85, 50–67.

Codd, J. (1988). The construction and deconstruction of educational policy documents. *Journal of Education Policy,* 3 (5), 235-48.

Connell, R.W. & White, V. (1989). Child poverty and educational action. In D. Edgar, D. Keane and P. McDonald (Eds.), *Child Poverty* (pp. 104-22). Sydney: Allen and Unwin.

Considine, M. (2002). The End of the Line? Accountable Governance in the Age of Networks, Partnerships, and Joined-Up Services. *Governance,15*(1), 21-40.

Costa, V. B. (1995) When science is 'another world': relationships between worlds of family, friends, school, and science. *Science Education*, 79, 313–333.

Crabtree, B.F. & Miller, W.L. (1991). A qualitative approach to primary care research: The long interview. *Family Medicine*, 23, 145-151.

Crabtree, B.F. & Miller, W.L. (1992a). The analysis of narratives from a long interview. In M. Stewart, F. Tudiver, M. Bass, et al (Eds.), *Tools for primary care research* (pp209-220). Newbury Park, CA: Sage.

Crabtree, B.F. & Miller, W.L. (1992b). A template approach to text analysis: Developing and using codebooks. In B.F. Crabtree & W.L. Miller (Eds.), *Doing qualitative research* (pp93-109). Newbury Park, CA: Sage.

Cross, R.T. (1997). Ideology and Science Teaching: Teachers' Discourse. *International Journal of Science Education,* 19(5), 607–616.

Cross, R.T.: 1999, 'Scientific Understanding: Lacey's "Critical Self-Consciousness" Seen as Echoes of J. D. Bernal', *Science & Education* 8(1), 67–78.

Cruikshank, J. (1981). Legend and landscape: Convergence of oral and scientific traditions in the Yukon Territory. *Arctic Anthology*, 18, 67–93.

Cruikshank, J. (1991). *Reading voices: Oral and written interpretations of the Yukon's past.* Vancouver, British Columbia: Douglas and McIntyre.

Darling- Hammond, L. (1993). Reframing the school reform agenda. *Phi Delta Kappan,* 74, 10, 753-761.

Darling-Hammond, L. (1994). National standards and assessment: will they improve education? *American Journal of Education,* 102, 478-510.

Dean, M. (1999). *Governmentality: power and rule in modern society.* London: Sage.

DeBoer, G. E. (1991). *A history of ideas in science education.* New York: Teachers College Press.

DeBoer, G.E. (2000). Scientific Literacy: Another Look at its Historical and Contemporary Meanings and its Relationship to Science Education Reform. *Journal of Research in Science Education,* 37(6), 582–601.

Deetz, S. (1998). Discursive formations, Strategised subordination and Self surveillance. In A. McKinlay and K. Starkey (Eds.), *Foucault, Management and Organisation Theory.* London : Sage Publications.

Denham, A. & Garnett, M. (1999). Influence without Responsibility: Think-Tanks in Britain. *Parliamentary Affairs, 52* (1), 46-57.

Denzin, N.K. & Lincoln, Y.S. (Eds.). (1994). *Handbook of Qualitative Research.* London: Sage Publications.

Department of Education (1995). *White Paper on Education and Training.* Government Gazette.

Department of Education (1997). *Curriculum 2005: Learning for the 21st century.* Pretoria.

Department of Education (2000a) *Report of the Review Committee on Curriculum 2005.* Pretoria: Government Printer.

Department of Education (2000b). *Report of the Study Team on the Implementation of the National Qualifications Framework.* Pretoria: Government Printer.

Department of Education (2000c). *Values Education and Democracy: report of a working group into values in education.* Pretoria: Government Printer.

Department of Education (July 2001a). *Draft revised National Curriculum Statement.* Pretoria

Department of Education (2001b). *Road Map for the Development of the NCS: Principles, Curriculum Overload and Qualification.* Pretoria.

Department of Education (2002). *Revised National Curriculum Statement Grades R-9 (Schools).* Pretoria: Government Printer.

Derrida, J. (1976). *On grammatology* (G. C. Spivak, Trans.). Baltimore: John Hopkins University Press.

Downie, J.R. & Barron, N.J. (2000). Evolution and Religion: Attitudes of Scottish First Year Biology and Medical Students to the Teaching of Evolutionary Biology. *Journal of Biological Education, 34*(3), 139–146.

Dreyfus, H.L. & Rabinow, P. (1982). *Michel Foucault: Beyond Structuralism and Hermeneutics*, Brighton, Harvester Press.

Driver, R., Asoko, H., Leach, J. & Mortimer, E. (1994). Constructing Scientific Knowledge in the Classroom. *Educational Researcher,* 23(7), 5–12.

Driver, R., Leach, J., Millar, R. & Scott, P. (eds.) (1996). *Young People' s Images of Science.* Philadelphia, PA: Open University Press.

Driver, R. & Osborne, J. (1998, April). Reappraising science education for scientific literacy. Paper presented at the annual meeting of the National Association for Research in Science Teaching (NARST), San Diego.

Dror, Y. (1964). Muddling through-science or interia? *Public Administration Review,* 24, 153-7.

Duit, R. (1998, April) Towards multi-perspective views of science learning and instruction. Paper presented at the annual meeting of the American Educational Research Association in San Diego.

Duit, R., & Treagust, D. (1998). Learning in science – From behaviourism towards social constructivism and beyond. In B. Fraser & K. Tobin (Eds.), *International handbook of science education* (pp. 3–26). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Durant, J. R. (Ed.) (1992). Museums and the public understanding of science. London: Science Museum in association with the Committee on the Public Understanding of Science.

Durant, J. R. (1993). What is scientific literacy? In J. R. Durant & J. Gregory (Eds.), *Science and culture in Europe* (pp. 129–137). London: Science Museum.

Eagleton, T. (1996). *Literary Theory- An Introduction.* Blackwell, Oxford.

Ebenezer, J.V. (1996). Christian Pre-service Teachers' Practical Arguments in a Science Curriculum and Instruction course. *Science Education,* 80(4), 437–476.

Egan, J. & Francis, L. (1992). Does Creationism Commend the Gospel. A Developmental Study Among 11–17 year olds. *Religious Education,* 87(1), 19–27.

Eisenhart, M., Finkel, E., and Marion, S.F. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal,33, 261-295.*

Eisner, E.W.(1992). Curriculum Ideologies. In P.W. Jackson (ed.), *Handbook of Research on Curriculum* (pp. 302–326). New York: MacMillan.

Elkana, Y. (1981). A programmatic attempt at an anthropology of knowledge. In E. Mendelshohn & Y. Elkana (Eds.), *Science and culture: Anthropological and historical studies of the sciences* (pp. 1–77). Dordrecht, The Netherlands: Reidel.

Engles, E.W.(1995).Early Twentieth-Century High School Biology Education: Naturalizing the Ideological Foundation of Capitalism. *Capitalism, Nature, Socialism,* 6(2), 49–73

Ernest, P. (1991). *The Philosophy of Mathematics Education.* London: The Falmer Press.

Evans, E.M. (2001). Cognitive and Contextual Factors in the Emergence of Diverse Belief Systems: Creation Versus Evolution. *Cognitive Psychology, 42*(3), 217–266.

Fensham, P., & Harlen, W. (1999). School science and public understanding of science. *International Journal of Science Education,* 21, 755–763.

Finch, J. (1984). *Research and Policy: The Uses of Qualitative Methods in Social and Educational Research.* London: Falmer Press.

Flower,M. J. (2000). Unsettling scientific literacy. *Liberal Education, 86(3),* 36-45.

Foucault, M. (1972). *The Archaeology of Knowledge and the Discourse of Language.* New York: Pantheon.

Foucault, M. (1973). *The Order of Things: An Archaeology of the Human Sciences.* New York: Vintage.

Foucault, M. (1979). *Discipline and Punish: The Birth of the Prison.* New York: Vintage.

Foucault, M. (1980). *Power/ Knowledge: Selected Interviews and Other Writings 1972*-1977. (ed.), C. Gordon, Brighton: Harvester Press.

Foucault, M. (1981). *The History of Sexuality.* Vol. 1. Harmondsworth: Penguin.

Foucault, M. (1985). *The Uses of Pleasure.* New York: Pantheon.

Foucault, M. (1988). *Madness and Civilization: A History of Insanity in the Age of Reason.* New York, Vintage.

Foucault, M. (1991). Governmentality. In G. Burchell, C. Gordon and P. Miller (eds), *The Foucault Effect: studies in governmentality* (87-104). Chicago, IL: University of Chicago Press.

Foucault, M. (1994) The subject and power, in J. Faubion (ed.), Michel Foucault: power: essential works of Michel Foucault 1954-1984, Vol. 3 (London: Penguin).

Fourez, G. (1988). Ideologies and Science Teaching. *Bulletin of Science, Technology & Society,* 8(3), 269–277.

Fourez, G. (1997). Scientific and technological literacy as a social practice. *Social Studies of Science, 27, 903-936.*

Francis, L.J. & Greer, J.E. (1999). Attitudes Towards Creationism and Evolutionary Theory: The Debate Among Secondary Pupils Attending Catholic and Protestant Schools in Northern Ireland. *Public Understanding of Science,* 8(2), 93–103.

Freeland, J. (1981). Where do they go after school? A critical analysis of one education program for unemployed youth. *The Australian Quarterly,* Spring: 351-73.

Gale, T. (2001). Critical policy sociology: historiography, archaeology and genealogy as methods of policy analysis. *Journal of Education Policy,* 16, 379-393.

Ganie, L. & Prinsloo, E. (1993). Product, People or Process: NEPI as a Research Training Process. *Perspectives in Education*, 14 (2), 215-220.

Geertz, C. (1988). *Works and lives: The anthropologist as author.* Stanford, CA: Stanford University Press.

Giddens, A. (1990). *The Consequences of Modernity.* Cambridge: Polity Press.

Giere, R. N. (1988). *Explaining Science: A Cognitive Approach.* Chicago: University of Chicago Press.

Giere, R.N. (1992). Cognitive Models of Science. In R. Giere (ed.), *Cognitive Models of Science.* Minneapolis: University of Minnesota Press.

Gil-Pérez, D. (1996). New Trends in Science Education. *International Journal of Science Education,* 18(8), 889–901.

Goodson, I.F. (1991). On understanding curriculum: the alienation of curriculum theory. In I.F. Goodson & K. Walker (Eds). *Biography, identity and schooling: episodes in educational practice.* London: Falmer.

Gordon, C. (1991) Governmental rationality: an introduction. In G. Burchell, C. Gordon and P. Miller (eds), *The Foucault Effect: studies in governmentality*(pp 1-52.). Chicago, IL: University of Chicago Press.

Gordon, I., Lewis, J. and Young, K. (1977). Perspectives on policy analysis, *Public Administration Bulletin,* 25, 26-35.

Gramsci, A. (1957). *The Modern Prince and Other Writings.* New York: International.

Greeno, J. G., Collins, A. M., & Resnick, L. B. (1997). Cognition and learning. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 15–46). New York: Simon & Schuster Macmillan.

Groaber, W., and Bolte, K. (Eds.) (1997). *Scientific literacy*. Kiel, Germany: IPN Leibniz-Institute for Science Education.

Guba, E.G. & Lincoln, Y.S. (1981). *Effective evaluation: improving the usefulness of educational results through responsive and naturalistic approaches.* San Francisco, California: Jossey-Bass.

Habermas, J. (1984). *The Theory of Communicative Action.* Boston: Beacon.

Halliday, M.A.K. & Matthiessen, C.M.I.M. (1999). *Construing Experience Through Meaning: A Language-Based Approach to Cognition.* Cassell: New York.

Hand, B.M., Prain, V., & Yore, L.D. (2001). Sequential writing tasks' influence on science learning. In P. Tynjala, L. Mason, & K. Lonka (Eds.), *Writing as a learning tool: Integrating theory and practice* (pp. 105–129). Dordrecht, The Netherlands: Kluwer

Hardesty, D. L. (1977). Ecological anthropology. New York: Wiley

Harlen, W. (2001). The assessment of scientific literacy in the OECD/PISA project. In H. Behrendt, H. Dahncke, R. Duit, W. Groaber, M. Komorek & A. Kross, (Eds), *Research in Science Education – past, present and future* (pp. 49–60). Dordrecht: The Netherlands: Kluwer Academic Publishers.

Harris, P. (1999) Public welfare and liberal governance. In A. Peterson, I. Barmes, J. Dudley and P. Harris (eds), *Poststructuralism, Citizenship and Social Policy* (25-64). London: Routledge.

Harvey, L. (1990). *Critical Social Research.* London: Allen and Unwin.

Henry, M. (1993). What is policy? A response to Stephen Ball. *Discourse, 14* (1), 102-5.

Hindess, B. (1996). Discourses of Power: from Hobbes to Foucault. Oxford: Blackwell.

Hirsch, E. D., Jr. (1987). *Cultural literacy: What every American needs to know*. Boston: Houghton Mifflin.

Hogwood, B. & Gunn, L. (1984). *Policy Analysis for the Real World,* Oxford: Oxford University Press.

Hua, H.-P., Chang, C.-Y., & Macraven, M.M.(1999). Taoism and Its Implications for Science Education. Paper Presented at the Annual Meeting of the National Association for

Research in Science Teaching, Boston, MA, March 28–31, 1999. Abstract from ERIC NO: ED430796.

Humes, W & Bryce, T. (2003). Post-structuralism and policy research in education. *Journal of Education Policy*, 18 (2), 175-187.

Hurd, P. (1958). Science literacy: Its meaning for American schools. *Educational Leadership*,16, 13–16, 52.

Jackson, D.F., Doster, E.C., Meadows, L & Wood, T. (1995). Hearts and Minds in the Science Classroom: The Education of a Confirmed Evolutionist. *Journal of Research in Science Teaching,* 32(6), 585–611.

Jacobs, L.R. & Shapiro, R.Y. (2000). *Politicians Don't Pander: Political Manipulation and the Loss of Democratic Responsiveness*. Chicago & London: University of Chicago Press.

Jansen, J. D. (1993). Curriculum reform in Zimbabwe: reflections for the South African transition. In N. Taylor (ed.), *Inventing Knowledge: Contests in Curriculum Construction* (58-68). Cape Town: Maskew Miller Longman.

Jansen, J. D. (1995). Understanding transition through the lens of curriculum policy: Namibia, 1990-1994. *Journal of Curriculum Studies*, 27(3), 245-261.

Jansen, J. D. (1998). Curriculum Reform in South Africa: A critical Assessment of Outcomes based Education. *Cambridge Journal of Education.* 28(3), 321-331.

Jansen, J.D. (1999a). The school curriculum since apartheid: intersections of politics and policy in South African transition. *Journal of Curriculum Studies*, 31 (1), 57-69.

Jansen, J.D. (1999 b). A very noisy OBE': The implementation of OBE in Grade 1 classrooms. In J. Jansen & P. Christie (Eds.) *Changing Curriculum. Studies on Outcomes-based Education in South Africa*. Cape Town: Juta.

Jansen, J.D. (1999 c). Why OBE will fail: An Elaboration. In J.D. Jansen & P. Christie (Eds.), *Changing Curriculum. Studies on Outcomes-based Education in South Africa*. Cape Town : Juta

Jansen, J & Christie,P. (Eds.) (1999).*Changing Curriculum. Studies on Outcomes-based Education in South Africa*. Cape Town : Juta

Jenkins, E. W. (1992). School science education: Towards a reconstruction. *Journal of Curriculum Studies*, 24(3), 229–246.

Jenkins, E. W. (1994). Scientific literacy. In T. Husen & T. N. Postlethwaite (Eds.), *The international encyclopedia of education* (Volume 9, 2nd ed., pp. 5345–5350). Oxford, UK: Pergamon Press.

Jenkins, E.W. (1999). School science, citizenship and the public understanding of science. *International Journal of Science Education*, 21, 703-710.

Kawagley, O. & Barnhardt, R. (1999). Education indigenous to place: Western science meets Native reality. In G. A. Smith and D. R. Williams (eds.), *Ecological Education in Action* (pp. 117–140). Albany, NY: SUNY Press.

Kenway, J. (1990). *Gender and Education Policy: A Call for New Directions.* Geelong: Deakin University Press.

Kincheloe, J. (1991). Educational historiographical meta-analysis: Rethinking methodology in the 1990s. *Qualitative Studies in Education,* 4(3), 231-245.

King, K. (1993). Education Policy in a Climate of Entitlement. *Perspectives in Education*, 14 (2), 199-207.

Kingdom, J.W. (1984). *Agenda, Alternatives and Public Policies.* Boston Toronto: Little Brown and Company.

Kliebard, H.M. (1987). *The struggle for the American curriculum 1893-1958.* New York: Routledge and Kegan Paul.

Kliebard, H. (1990) Curriculum policy as symbolic action: connecting education with the workplace. In H. Haft and S. Hopmann (eds.), *Case Studies in Curriculum Administration History* (pp. 143–15). London: Falmer Press.

Klopfer, L.E. (1969). The teaching of Science and the History of Science. *Journal of Research in Science Teaching,* 6, 87-95.

Knain, E. (2001). Ideologies in School Science Textbooks. *International Journal of Science Education,* 23(3), 319–329.

Korpan, C.A., Bisanz, J., & Henderson, J.M. (1997). Assessing Literacy in Science: Evaluation of scientific news briefs. *Science Education,* 81, 515-532.

Kraak, A. (1999). Competing Education and Training Policy Discourses: A 'Systemic' versus 'Unit Standards' Framework. In Jansen, J & Christie, P. (Eds.) *Changing Curriculum. Studies on Outcomes-based Education in South Africa.* Cape Town : Juta.

Kristeva, J. (1980). *Desire in language.* New York: Columbia University Press.

Kuhn, D. (1993). Science as Argument: Implications for Teaching and Learning Scientific Thinking. *Science Education,* 77(3), 319–337.

Kyle, W. C., Jr. (1995a). Scientific literacy: How many lost generations can we afford? *Journal of Research in Science Teaching*, 32(9), 895–896.

Kyle, W. C., Jr. (1995b). Scientific literacy: Where do we go from here? *Journal of Research in Science Teaching*, 32(10), 1007–1009.

Labaree, D. (1997). Public goods, private goods: the American struggle over educational goals. *American Educational Research Journal*, 34 (1): 39-82.

Lasswell, H. (1970). The emerging conception of policy sciences. *Policy Sciences*, 1, 3-14.

Latour, B. (1987). *Science in Action: How to follow scientists and Engineers through society.* Milton Keynes, UK: Open University Press.

Layton, D., Jenkins, E., Macgill, & Davey, A. (1993). *Inarticulate science?* Nafferton, UK: Studies in Science Education.

Laugksch, R.C.(2000). Scientific Literacy: A Conceptual Overview. *Science Education* 84(1), 71–94.

Le Compte, M. D., Millroy, W. and Preisle, J. (eds). (1992). *The Handbook of Qualitative Research in Education*. San Diego: Academic Press.

Lee, S., and Roth, W-M. (2001). *Community Science: What is essential about this strange dialogue?* Paper presented at Taking Nature Seriously: Citizens, Science, and Environment.

Lee, S., and Roth, W-M. (in press). How ditch and drain become a healthy creek: Representations, translations and agency during the re/design of a watershed. *Social Studies of Science.*

Lemke, J. (1990). *Talking Science: Language, Learning and Values*. Norwood : Ablex Publishing.

Lewin, K., Samuel, M., & Sayed, Y. (eds.) (2003). *Changing Patterns of Teacher Education: Policy, Practice and Prospects.* Heinemann Publishers: Cape Town.

Lewenstein, B. V. (1989). Magazine publishing and popular science after World War II. *American Journalism*, 6(4), 218–234.

Liberatore, A. (2001). From Science/Policy Interface to Science/Policy/Society Dialogue, in OECD Proceedings, *Social Sciences for Knowledge and Decision Making*. Paris: OECD, pp.117-128.

Lijnse, P. (2000). Didactics of Science: The Forgotten Dimension in Science Education Research? In R. Millar, J. Leach & J. Osborne (eds.), *Improving Science Education: The Contribution of Research.* Open University Press, Buckingham.

Lindblom, C.E. (1959). The science of muddling through. *Public Administration Review*, 19, 79-88.

Lindblom, C.E. (1968). *The Policy Making Process.* Engelwood Cliffs, NJ: Prentice Hall.

Ling, L.M. (2003). Education Policy: Whose voice, whose silence? http://www.lhs.se/atee/papers/concurrent-5.doc. (retrieved 24 September 2003).

Locke, D. (1992). *Science as writing.* New Haven, NJ: Yale University Press.

Loving, C.C. & Foster, A. (2000). The Religion-in-the-science-classroom issue: Seeking Graduate Student Conceptual Change. *Science Education,* 84(4), 445–468.

Lubisi, R. C. (1999). *Assessment in Education: Principles, practice and critique.* Pietermaritzburg: University of Natal Press.

Lubisi, R. C. & Murphy, R. J.L. (2002). Assessment in South African Schools. *Assessment in Education*, *9* (2), 255-268.

Lucas, A. M. (1991). Infotainment and informal sources for learning science. *International Journal of Science Education*, 13(5), 495–504

Luke, A., Nakata, M., Singh, M., and Smith, R. (1993). Policy and the politics of representation: Torres Strait Islanders and Aborigines at the margins. In B. Lingard, J. Knight and P. Porter (eds.), *Schooling Reform in Hard Times (*pp139-52). London: Falmer Press.

Lungu, G.F. (2001). The educational policy process in post-apartheid South Africa: an analysis of structures. In Y. Sayed and J.D. Jansen (eds). *Implementing Education Policies: The South African Experience.* UCT Press.

Maarschalk, J. (1988). Scientific literacy through informal science teaching. *International Journal of Science Education,* 8(4), 353–360.

Mahon, M. (1992). *Foucault's Nietzschean Genealogy: Truth Power, and the Subject.* New York: State University Press.

Malcolm, C. (2001). Implementation of outcomes-based approaches to education in Australia and South Africa: A comparative study. In Sayed, J. & Jansen, J.D. (Eds.) *Implementing Education Policies: The South African experiences.* Cape Town: UCT Press.

Malcolm, C. & Alant, B. (2004). Finding direction when the ground is moving: science education research in South Africa. *Studies in Science Education (*in press).

Manganyi, N.C. (1991). *Treachery and innocence: Psychology and racial difference.* Johannesburg: Ravan Press.

Maquire, M. & Ball, S.J. (1994). Researching politics and the politics of research. *International Journal of Qualitative Studies in Education,* 7(3): 269-85.

March, J.G. & Simon, H.A. (1958). *Organisations,* London: John Wiley.

Marnewick, L. & Spreen, C. (1999). Dancing with the monster: mastering the steps of OBE in the Northern Province. *Unpublished.*

Matthews, M.R. (ed.) (1996). Religion and Science Education [Special issue]. *Science & Education,* 5(2).

Matthews, M.R. (ed.) (1999). Values in Science and in Science Education [Special issue]. *Science & Education,* 8(1).

McCracken, G. (1988). *The long interview.* Newbury Park, CA: Sage.

McKinley, E., McPherson, W. P. & Bell, B. (1992). Language, culture and science education. *International Journal of Science Education*, 14, 579–595.

McRae, M. W. (Ed.) (1993). *The literature of science. Perspectives on popular science writing.* Athens, A: University of Georgia Press.

Merriam,S.B. (1988). *Case Study research in education: a qualitative approach.* California: Jossey-Bass.

Metcalfe, M. (1997). *Against all odds: Education in South Africa.* A Lord Alexander memorial lecture: Society of education officers conference. Chester : London.

Miles, M.B., & Huberman, A.M. (1984). *Qualitative data analysis: A sourcebook of new methods.* Beverly Hills, CA: Sage.

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus*, 112(2), 29–48.

Miller, J. D. (1989, February). Scientific literacy. Paper presented at the annual meeting of the American Association for the Advancement of Science, San Francisco, CA.

Miller, J. D. (1992). Toward a scientific understanding of the public understanding of science and technology. *Public Understanding of Science*, 1(1), 23–26.

Miller, W.L. & Crabtree, B.F. (1992). Primary care research: A multimethod typology and qualitative roadmap. In B.F. Crabtree & W.L. Miller (Eds.), *Doing qualitative research (pp3-28).* Newbury Park, CA: Sage.

Moerman, M. (1988). *Talking culture.* Philadelphia: University of Pennsylvania Press.

Moodie, T. (2003). Alternative ways of knowing – doing justice to non-western intellectual traditions in a post-modern era. *Journal of Education*, 31: 7-25.

Morrow,W. & King, K. (1998). *Vision and Reality: changing education and training in South Africa.* Cape Town: UCT Press.

Moser, C.A. & Kalton, G. (1977). *Survey methods in social investigation.* 2nd edition. London: Heinemann Educational Books.

Motala, S. (1995). Surviving the system – a critical appraisal of some conventional wisdoms in primary education in South Africa. *Comparative Education,*31 (2).

Moustakas, C. (1990). *Heuristic research: Design, methodology, and applications.* Newbury Park, CA: Sage.

Muller, J. (2000). *Reclaiming knowledge. Social theory, curriculum and education policy.* London: Routledge Falmer.

Murdock, G.P., Ford, C.S., Hudson, A.E., et al. (1950). *Outline of cultural materials (3rd ed.).* New Haven, CT: Human Relations Area Files.

Nasseef, A.O. (1994). Science Education and Religious Values: An Islamic Approach. In S.A. Johnson(ed.), *Textbooks in the Kaleidoscope. A Critical survey of Literature and Research onEducational Texts.* Oslo: Scandinavian University Press.

National Education and Training Forum (NETF) (1995). Curriculum Technical Sub-Committee: Agenda and recommendations, tabled at meeting of 27 March 1995, Document B (Johannesburg: NETF).

National Research Council (NRC) (1996). *National Education Standards.* http://www.nap.edu/catalog/4962.html

National Science Board [NSB] (1991).Science & Engineering Indicators—1991 (NSB91-1). Washington, DC: U.S. Government Printing Office.

National Science Board (1993). Science & Engineering Indicators—1993 (NSB93-1). Washington, DC: U.S. Government Printing Office.

National Science Board (1996). Science & Engineering Indicators—1996 (NSB96-21). Washington, DC: U.S. Government Printing Office

NECC, (1992). *NEPI: The Framework Report.* Cape Town: Oxford University Press.

NECC, (1993). *The Curriculum Report.* Cape Town: Oxford University Press.

Nelkin, D. (1995). *Selling science: How the press covers science and technology*. New York: Freeman.

Nelson, R. K. (1983). Make prayers to the raven: A Koyukon view of the northern forest (pp. 200–237). Chicago: University of Chicago Press

Newton, P., Driver, R. & Osborne, J. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education*, 21, 553–576.

Newton-Smith, W. (1981). *The Rationality of Science.* , London: Routledge.

Norris, S.P. & Phillips, L.M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education,* 87, 224–240.

OECD-PISA (1999). *Measuring student knowledge and skills: A new framework for assessment.* Paris: OECD.

Ogawa, M. (1989). Beyond the tacit framework of "science" and "science education" among science educators. *International Journal of Science Education*, 11, 247–250.

Ogawa, M. (1995). Science education in a multi-science perspective. *Science Education*, 79, 583–593.

Ogborn, J., Kress, G., Martins, I. & McGillicuddy, K. (1996). *Explaining Science in the Classroom.* Buckingham: Open University Press.

Ohlsson, S. (1992). The Cognitive Skill of Theory Articulation: A Neglected Aspect of Science Education?' *Science & Education, 1*(2), 181–192.

O'Niel, J. (1994). Aiming for new outcomes: the promise and the reality. *Educational Leadership,* 51, 6, 6-10.

Osborne , J. F. (1996) Beyond constructivism. *Science Education*, 80(1) , 53±82.

Osborne, J.F. (1999). Promoting Argument in the Science Classroom: A Rhetorical Perspective. *ESERA Conference*, Kiel, Germany.

Ozga, J. (2000). *Policy Research in Educational Settings*. Buckingham: Open University Press.

Ozga, J. & Gewirtz, S. (1994). Sex, lies and audiotape: Interviewing the education policy elite. In D. Halpin and B. Troyna (eds.), *Researching Education Policy: Ethical and Methodological Issues (*pp121-35). London: Falmer Press.

Pella, M. O., O'Hearn, T., & Gale, C. (1966). Referents to scientific literacy. *Journal of Research in Science Teaching*, 4, 199–208.

Peters, M. (1996). *Poststructuralism, Politics and Education.* Westport, CT: Bergin & Garvey.

Pickering, A. (1995). *The Mangle of Practice: Time, Agency and Science.* Chicago, IL: University of Chicago Press.

Pomeroy, D. (1994). Science education and cultural diversity: Mapping the field. *Studies in Science Education*, 24, 49–73.

Poole, M. (1995). *Beliefs and Values in Science Education.* Buckingham: Open University Press.

Popkewitz, T.S. (1996). Rethinking decentralization and the state/civil society dictinctions: The state as a problematic of governing. *Journal of Education Policy, 11*,27-51.

Popkewitz, T. S. & Simola, H. (1996). Academic discourses, professionalization, and the construction of the teacher in the USA. In Hannu Simola,& Thomas S. Popkewitz (eds.), *Professionalization and education* (pp.119-146). Helsinki: University of Helsinki.

Prenzel, M., & Duit, R. (2000, April). Increasing the efficiency of science and mathematics instruction: report of a national quality development programme. Paper presented at the annual meeting of the National Association for Research in science Teaching (NARST), New Orleans.

Procacci, G. (1991). Social economy and the government of economy. In G. Burchell, C. Gordon and P. Miller (eds.), *The Foucault Effect: studies in governmentality* (pp 151-168). Chicago, IL: University of Chicago Press.

Quin, M. (1993). Clone, hybrid or mutant? The evolution of European science museums. In J. R. Durant, & J. Gregory (Eds.), Science and culture in Europe. (pp. 195–201). London: Science Museum.

Raab, C.D. (1994). Where we are now: Reflections on the sociology of education policy, in D.Halpin & B. Troyna (eds), *Researching Education Policy: Ethical and Methodological Issues*, London: Falmer Press.

Rein, M. (1983). *From Policy to Practice.* London: Macmillan.

Reiss, M.J. (1999). Teaching Ethics in Science. *Studies in Science Education,* 34, 115–140.

Rizvi, F. & Kemmis, (1987). *Dilemmas of Reform: The Participation and Equity Program in Victorian Schools.* Geelong: Deakin Institute for Studies in Education.

Roberts, D. A. (1983). *Scientific literacy: Towards a balance for setting goals for school science programs*. Ottawa, ON, Canada: Minister of Supply and Services.

Roberts, D.A. (1998). Analyzing School Science Courses: The Concept of Companion Meaning. In D.A. Roberts & L. Östman (eds.), *Problems of Meaning in Science Curriculum (*pp5-12). New York : Teachers College Press.

Roberts, H. (ed) (1981). *Doing Feminist Research.* London: Routledge and Kegan Paul.

Rose, N. & Miller, P. (1990), Governing economic life, *Economy & Society*, 19 (1).

Rose, N. and Miller, P. (1992). Political power beyond the state. *British Journal of Sociology*, 43(2).

Rose, N. (1996) Governing 'advanced' liberal democracies. In A. Barry, T. Osborne and N. Rose (eds), *Foucault an Political Reason: liberalism, neo-liberalism an rationalities of government* (37-64). London: UCL Press.

Rose, N. (1999). *Powers of freedom. Re-framing political thought.* Cambridge: Cambridge University Press.

Roth, W.-M. & Alexander, T. (1997). The Interaction of Students' Scientific and Religious Discourses: Two Case Studies. *International Journal of Science Education,* 19(2), 125–146.

Roth W-M. & Tobin, K. 2002. *At the Elbow of Another: Learning to teach Co-teaching.* New York: Peter Lang.

Rutherford, F.J., & Ahlgren, A.(1990).*Science for All Americans.* New York: Oxford University Press.

Said, E. (1986). Foucault and the imagination of power. In D. Hoy, (ed), *Foucault: A Critical Reader.* Oxford: Blackwell.

Scheurich, J.J. (1997). Policy Archaeology: A New Policy Studies Methodology. In J.J. Scheurich (ed.), *Research Method in the Postmodern.* Washington DC: The Falmer Press.

Schneider, A. & Ingram, H. (1990). Behavioural assumptions of policy tools. *Journal of Politics*, 52(2), 511-529.

Scribner, S. (1986). Literacy in three metaphors. In N.Stein (ed), *Literacy in American Schools: Learning to read and write* (7-22). Chicago: University of Chicago Press.

Sewall, G.T. (ed.) (1999). Religion and the School [Special issue]. *Phi Delta Kappan,* 81(1).

Shamos, M. H. (1989). Views of scientific literacy in elementary school science programs: Past, present, and future. In A. B. Champagne, B. E. Lovitts, & B. J. Callinger (Eds.), *This year in school science. Scientific literacy* (pp. 109–127). Washington, DC: AAAS .

Shamos, M. H. (1995). *The myth of scientific literacy.* New Brunswick, NJ: Rutgers University Press.

Shapin, S. (1999). Rarely pure and never simple: Talking about truth. Configurations, 7, 1–14.

Shapiro, R.Y. & Jacobs, L.R. (2001). Source Material: Presidents and Polling: Politicians, Pandering, and the Study of Democratic Responsiveness. *Presidential Studies Quarterly, 31*(1), 150-167.

Showalter, V. M. (1974). What is united science education? Part 5. Program objectives and scientific literacy. *Prism* II, 2 (3- 4).

Simon, H.A. (1957). *Administrative Behaviour*, 2nd Edition. London: Macmillan.

Simon, H.A. (1960). *The New Science of Management Decision.* Englewood Cliffs, NJ: Prentice Hall.

Simon, H.A. (1983). *Reason in Human Affairs.* Oxford: Blackwell.

Sjøberg, S. (1995). Meanings and Ideologies, the Shaping of School Science. *Journal of Nordic Educational Research,* 15(4), 235–246.

Smith, B.M. (ed.) (2000).Science and Religion. [Special issue]. *Phi Delta Kappan* 81(6).

Smith, J.A. (1991). *The Idea Brokers: Think Tanks and the Rise of the New Policy Elite.* New York: The Free Press.

Singh, S. (2000). Intruders in the sacred grove of science? A critical analysis of women academics participation in research in the humanities and social sciences. Published PhD dissertation, University of Durban Westville.

Snively, G. and Corsiglia, J. (2001). Discovering indigenous science: implications for science education. *Science Education*, 85, 6–34.

Solomon, J., Duveen, J. & Scott, L. (1994). Pupil's Images of Scientific Epistemology. *International Journal of Science Education,* 16(3), 361–373.

Spradley, J.P. (1979). *The ethnographic interview.* New York: Holt, Rinehart & Winston.

Spradley, J.P. (1980). *Participant observation.* New York: Holt, Rinehart & Winston.

Spreen, C.A. (2000). Globalisation and Educational Policy Borrowing: Mapping Outcomes Based Education in South Africa. PhD. Dissertation in Comparative and International Education. New York: Columbia University, Graduate School of Arts and Sciences.

Stanley, W. B., & Brickhouse, N. W. (2001). Teaching sciences: The multicultural question revisited. *Science Education*, 85, 35–49.

Stein, H.F. (1990). American medicine as culture. Boulder, CO: Westview.

Strauss, A.L. & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park, CA: Sage.

Stoller, P. (1992). *The taste of ethnographic things.* Philadelphia: University of Pennsylvania Press.

Stone, D. (1996). *Capturing the Political Imagination: Think Tanks and the Policy Process.* London: Frank Cass.

Stone, D. (2000a). Non-Governmental Policy Transfer: The Strategies of Independent Policy Institutes. *Governance, 13(*1), 45-62.

Stone, D. (2000b). Think Tank Transnationalisation and Non-profit Analysis, Advice and Advocacy. *Global Society, 14* (2), 153-172.

Stone, D., Denham, A. & Garnett, M. (Eds.). (1998). *Think tanks across nations: A comparative approach*. Manchester: Manchester University Press.

Stronach, I. & Maclure, M. (1997). *Educational Research Undone.* Buckingham: Open University Press.

Struyk, R.J. (2002). Transnational think-tank networks: purpose, membership and cohesion. *Global Networks,2* (1), 83-90.

Suchting, W.A. (1983). *Marx: An Introduction.* New York University Press, New York.

Tarnas, R. (1996). *The Passion of the Western Mind.* Ballantine Books, New York.

Taylor, N. (2001). Anything but knowledge: The case of the undisciplined curriculum. Paper presented at the Curriculum Dialogue Seminar: 'What counts as worthwhile knowledge for the 21st century South African citizen? GICD, Johannesbury, 14 February 2001.

Taylor, N. & Vinjevold, P. (1999). *Getting Learning Right – Report of the President's Education Initiative Research Project*. Johannesburg: Jet

Taylor, S. (1997). Critical policy analysis: exploring contexts, texts and consequences. *Discourse, 23*(13), 23 -35.

Taylor, S., Rizvi, F., Lingard, B. Henry& M. (1997). *Educational Policy and the Politics of Change,* London and New York: Routledge.

Tema, B. (1997). Classroom Practice in OBE. *Jet Bulletin,* 7, 15 – 19.

Tickly, L. (2003). Governmentality and the study of education in South Africa. *Journal of Education Policy*, 18 (2), 161-174.

Troyna, B. (1994).Critical social research and education policy. *British Journal of Educational Studies* 42 (2), 70-84.

Turnbull, D. (1997). Reframing science and other local knowledge traditions. *Futures*, 29, 551–562.

Tyler, S.A. (1987). *The unspeakable: Discourse, dialogue, and rhetoric in the postmodern world.* Madison: University of Wisconsin Press.

Tytler, R., and Conley, H. (2001). The science in schools research project: improving science teaching and learning in Australian schools. In D. Psillos, P. Kariotoglou, V. Tselfes, G.Bisdikian, G. Fassoulopoulos, E. Hatzikraniotis & M. Kallery (Eds.), *Proceedings of the Third International Conference on Science Education Research in the Knowledge Based Society. Vol. 1* (pp. 204–206). Thessaloniki, Greece: Aristotle University of Thessaloniki.

Unterhalter, E. (1998). Stakeholding and school governance in South Africa: devolution, democratisation or disguise, Paper presented to the World Comparative Education Conference, Cape Town, 14-18 July.

Unterhalter, E. (2000). South African education research and the contradictions of globalisation. *Journal of Education,* 25, 1-18.

Valero, P.& Vithal, R. (1998). Research methods of the "North" revisited from the "South". Paper presented at the 22nd Conference of the International group of Psychology of Mathematics Education, University of Stellenbosch, Conference proceedings edited by A. Oliver & K. Newsted, 12-17 July 1998.

Vithal, R. (1998). Disruptions and data: the politics of doing mathematics education research in South Africa. Paper presented at the 6th Annual Meeting of Southern African Association for Research in Mathematics and Science.

Weiler, H. (1983). Legalization, expertise, and participation: strategies of compensatory legitimation in educational policy. *Comparative Education Review*, 27(2), 259-277.

Westbury, I. (1973). Conventional classrooms, 'open' classrooms and the technology of teaching. *Journal of Curriculum Studies,* 5 (2).

Wiggins, G. (1991). Standards, not standardization: evoking quality student work. *Educational Leadership,* 48, 5, 18-25.

Willems, E.P. & Rausch, H.L. (1969). *Naturalistic viewpoints in psychological research.* New York: Holt, Rinehart & Winston.

Willis, S. (1998). Perspectives on Social Justice, Disadvantage, and the Mathematics Curriculum. In C. Keitel (ed.), *Social Justice and Mathematics Education: Gender, Class, Ethnicity and Politics of Schooling* (pp 1-19). Berlin, Germany: Freie Universitat.

Willis, S. & Johnston, J. (1998). Is it possible to base systemic curriculum reform on principles of social justice. In C. Keitel (ed.), *Social Justice and Mathematics Education: Gender, Class, Ethnicity and Politics of Schooling* (pp 123-134). Berlin, Germany: Freie Universitat.

Willms, D.G., Best, J.A., Taylor, D.W. et al. (1990). A systematic approach for using qualitative methods in primary prevention research. *Medical Anthropology Quarterly,* 4, 391-409.

Witz, K. G. (1996). Science with Values and Values for Science Education. *Journal of Curriculum Studies,* 28(5), 597–612.

Wynne, B. (1991). Knowledges in context. *Science, Technology, & Human Values*, 16(1), 111–121.

Wynne, B. (1992). Public understanding of science research: New horizons or hall of mirrors? *Public Understanding of Science,* 1(1), 37-43.

Ziman, J. (1991). Public understanding of science. *Science, Technology, & Human Values,* 16(1), 99-105.

Appendices

Appendix A: Analysis of Policy Documents in Eight Learning Areas for Form in C2005 and the NCS

Appendix B: Content Summary and Analysis of C2005 Natural Science Policy Document

Appendix C: Content Analysis of the National Curriculum Statements for Natural Science (NCS- July 2001) for the GET Phase

Appendix D: Appendix D: Content Analysis of the Revised National Curriculum Statements for Natural Science GET phase (RNCS)

Appendix E: Content Analysis of the Australian Curriculum Statements

Appendix F: Interview Schedule

Appendix G: Questionnaire

Appendix A:

Analysis of Policy Documents in Eight Learning Areas for Form in C2005 and the NCS

C2005

Construct	LEARNING AREAS: LLC	HSS	TECH	MLMMS
What is the structure of the policy document?	1) rationale 2) specific outcomes 3)defining concepts: text, literacy, language, outcomes, outcomes and skills, learning programmes 4) assessment 5) For each of the specific outcomes: a) explanation of the outcome b) range statement c) assessment criteria and performance indicators d) levels of complexity	1) rationale 2) Specific Outcomes 3) Organising Principles 4) For each of the specific outcomes: NB: a) an explanation of the outcome 9 only b) assessment criteria c) range statements d) performance indicators	1) definition 2) rationale 3) Specific Outcomes 4) For each specific outcome: a) explanation of the outcome b) assessment criteria c) range statement d) performance indicators	1) definition 2) rationale 3) specific outcomes 4) For each specific outcome: a) explanation of the outcome b) assessment criteria c) range statements d) performance indicators
Does the rationale make explicit: Why the learning field is seen as important to include in the curriculum?	The document makes explicit the potential to: >make meaning >negotiate meaning and understanding >access education >access information and literacies >think and express their thoughts and emotions logically, critically and creatively >respond with empathy to the thoughts and emotions of others >interact and participate socially, politically, culturally and spiritually >understand the relationship between language and power, and influence relationships through this	The document makes explicit the ability of the HSS learning area to contribute to developing responsible citizens in a culturally diverse, democratic society within an interdependent world. They will equip learners to make sound judgements and take appropriate actions that will contribute to sustainable development of human society and the physical environment	The document makes explicit that the technology learning area seeks to develop: >an ability to solve technological problems by investigating, designing, developing, evaluating as well as communicating effectively in their own and other languages and by using different modes; >a fundamental understanding of and ability to apply technological knowledge, skills and values, working as individuals and as group members, in a range of technological contexts;	The document makes explicit that the MLMMS as domains of knowledge are significant cultural achievements of humanit They have both utilitarian and intrinsic value. All people ha a right of access to these domains and their benefits. These domains provide powerful numeric, spatial, temporal, symbolic, communicative and other conceptual tools, skills knowledge, attitudes and values to analyse, make and justify critical decisions, and take transformative action.

	understanding >develop and reflect critically on values and attitudes >communicate in different contexts using a range of registers and language varieties; and >use standard forms of language where appropriate		>a critical understanding of the interrelationship between technology, society, the economy and the environment	
What constitutes the essential elements of the field?	Not made explicit	Study of relationship between people, and between people and the environment. These relationships are contextualised in space and time and have social, political, economic, environmental and spiritual dimensions	Not made explicit but the learning area is defined as: technology is the use of knowledge, skills and resources to meet human needs and wants and to recognize and solve problems by investigating, designing, developing and evaluating products, processes and systems	Not made explicit but the learning area is defined as: mathematics is the construction of knowledge that deals with qualitative and quantitative relationships of space and time. is a is a human activity that deals with patterns, problem solving, logical thinking, e in an attempt to understand the world and make use of that understanding. This understanding is expressed, developed and contested through language, symbols and social interaction.
How the learning field contributes to the critical outcomes?	Not explicitly stated but can be inferred from specific outcomes	Not explicitly stated but can be inferred from specific outcomes	Not explicitly stated but can be inferred from specific outcomes	Not explicitly stated but can be inferred from specific outcomes
How does the rationale articulate with the principles of OBE: Learner centred-ness and lifelong learning	The document states that LLC are intrinsic to human development and central to lifelong learning	Not made explicit	Not made explicit	Not made explicit
How are the outcomes defined?	Seven specific outcomes	Nine specific outcomes	Seven Specific outcomes	Ten specific outcomes

Is a value framework explicit in the statement of outcomes?	Outcome 1: Learners make and negotiate meaning and understanding Outcome 3: learners respond to the aesthetic, affective, cultural and social values in text.	Outcome 3: Participate actively in promoting a just, democratic and equitable society Outcome 4: Make sound judgements about the development, utilization and management of resources Outcome 7: Address social and environmental issues in order to promote development and social justice	Outcome 2: apply a range of technological knowledge and skills ethically and responsibly Outcome 4: select and evaluate products and systems Outcome 7: demonstrate an understanding of how technology might reflect different biases, and create responsible and ethical strategies to address them.	Outcome 6: use data from various contexts t make informed judgements

C2005 continued

LEARNING AREAS

Construct	NS	EMS	AC	LO
What is the structure of the policy document?	1) preamble that details the commitment of the NS learning area, and brief notes on the rationale, specific outcomes, conceptualization of the natural sciences, assessment criteria, range statements and exemplars, and other considerations 2) rationale 3) specific outcomes 4)conceptualization of the natural sciences 5) For each of the specific outcomes: a) explanation of the outcome b) assessment criteria c) range statement d) performance indicators	1) rationale 2) specific outcomes 3)explanatory notes: differentiation between phases, use of examples, sequence of assessment criteria 4) For each of the specific outcomes: a) explanation of the outcome b) assessment criteria c) range statement d) performance indicators	1) principles of Arts and Culture Education and Training 2) Conceptualisation of Arts and Culture education and training 3) rationale 4)preamble to specific outcomes for Arts and Culture 5) reclaiming indigenous practices 6) specific outcomes 7) For each of the specific outcomes: a) explanation of the outcome b) assessment criteria c) range statement d) performance indicators	1) rationale 2) specific outcomes 3) justification for selection of the specific outcomes 4) For each of the specific outcomes: a) explanation of the outcome b) assessment criteria c) range statement d) performance indicators

Does the rationale make explicit: Why the learning field is seen as important to include in the curriculum?	The document explicitly states that the development of appropriate skills, knowledge and attitudes and an understanding of the principles and processes of the Natural Sciences: enable learners to make sense of the natural world, contribute to the development of responsible, sensitive and scientifically literate citizens who can critically debate scientific issues and participate in an informed way in democratic decision-making processes, are essential for conserving, managing, developing and utilizing natural resources to ensure the survival of local and global environments, and contribute to the creation and shaping of work opportunities	The document explicitly states that this learning area is fundamental in preparing the citizens of South Africa to understand the critical importance of reconstruction, development and economic growth for a sustainable economic future. Through this learning area learners will be equipped with the knowledge and comprehension of economic and management skills and competences that will enable them to play a vital role in the process of transforming the country's economic, social, political, technological, physical and demographic environments and introduced to an understanding of the wealth creation processes by equipping them with the necessary and knowledge in the different spheres of the economy.	The document explicitly states: Arts and Culture are an integral part of life, embracing the spiritual, material, intellectual and emotional aspects of human society. Culture embodies not only expression through the arts, but lifestyles, behavior patterns, heritage, knowledge and belief systems.	The document explicitly states that life orientation is fundamental i empowering learners to live meaningful lives in a society that demands rapid transformation ion it is an integral part of education, training and development; it is central to the holistic unfolding of the learners, caring for their intellectual, physical, personal, social, spiritual and emotional growth, and for the way these facets work together; it locates its vision of individual growth within the quest for a free, democratic and stable society, for quality of life in a community and for a productive economy.
What constitutes the essential elements of the field?	The document states that the Natural Sciences, comprising the physical, life, and earth sciences, involve the systematic study of the material universe- including natural and human-made environments-as a set of related systems. A variety of methods, that have in common the collection, analysis and critical evaluation of data, are used to develop scientific knowledge. Learners need to know that science is a human activity, dependent on assumptions that change over time and over different social settings.	Not made explicit in the rationale but aims to equip learners with the necessary knowledge in the different spheres of the economy such as basic economics, management, finance, administration and institutions	Not made explicit in the rationale but can be inferred through the preamble.	Not explicitly stated
How the learning field contributes to the critical	Not explicitly stated but can be inferred from specific outcomes	Not explicitly stated but can be inferred from specific outcomes	Not explicitly stated but can be inferred from specific outcomes	Not explicitly stated but can be inferred from specific outcomes

outcomes? How does the rationale articulate with the principles of OBE: Learner centred-ness, lifelong learning and integration	The document states that learners should be active participants in the learning process in order to build a meaningful understanding of concepts which they can apply in their lives.	Not made explicit	The preamble explicitly states the engagement of learners in an intergrated arts approach at three levels: linking knowledge and understanding with skills, interdisciplinary interaction of various art forms and integration across learning areas	Not made explicit
How are the outcomes defined? Is a value framework explicit in the statement of outcomes?	Nine specific outcomes Outcome 5: Use scientific knowledge and skills to support responsible decision making Outcome 8: demonstrate knowledge and understanding of ethical issues, bias and inequities related to the Natural Science	Eight Specific outcomes Outcome 6: Evaluate different economic systems from various perspectives	Eight specific outcomes Outcome 7: Demonstrate an ability to access creative arts and cultural processes to develop self esteem and promote healing	Eight specific outcomes Outcome 2: Use skills and display attitudes and values that improve relationships in family, grou[p] and community Outcome 3: Respect the rights of people to hold personal beliefs and values Outcome 4: Demonstrate value and respect for human rights as reflected in *Ubuntu* and other similar philosophies Outcome 7: Demonstrates the values and attitudes necessary for a healthy and balanced lifestyle. Outcome 8: Evaluate and participate in activities that demonstrate effective huma[n] movement and development

NCS

Construct	LLC	HSS	TECH	MLMMS
What is the structure of the policy document?	**Chapter 1 : Introduction** 1.1 Introducing the National Curriculum Statement a) OBE b) Revised NCS: LA statements c) Revised NCS: learning programmes d) Time allocation e) Assessment f) The Kind of Teacher that is Envisaged g) The Kind of Learner that is Envisaged 1.2 Introducing the Languages LA a) definition b) the additive approach to multilingualism c) purpose d) unique features and scope e) languages learning outcomes **Chapter 2: Foundation Phase (grades R-3)** 2.1 Introduction focus developing language knowledge-grammar, vocabulary, and pronunciation 2.2 Learning Outcomes 2.3 Assessment Standards and texts for grade R and grades 1-3 per each learning outcome	**Chapter 1 : Introduction** 1.1 Introducing the National Curriculum Statement a) OBE b) Revised NCS: LA statements c) Revised NCS: learning programmes d) Time allocation e) Assessment f) The Kind of Teacher that is Envisaged g) The Kind of Learner that is Envisaged 1.2 Introducing the Social Sciences LA a) definition b) purpose c) unique features and scope: history, geography e) social science learning outcomes: history, geography **Chapter 2: Foundation Phase (grades R-3)** 2.1 History introduction, learning outcomes, knowledge focus for each grade, assessment standards for each learning outcome 2.2 Geography	**Chapter 1 : Introduction** 1.1 Introducing the National Curriculum Statement a) OBE b) Revised NCS: LA statements c) Revised NCS: learning programmes d) Time allocation e) Assessment f) The Kind of Teacher that is Envisaged g) The Kind of Learner that is Envisaged 1.3 Introducing the Technology LA a) definition f) purpose g) unique features and scope: **Chapter 2: Foundation Phase (grades R-3)** 2.1 Introduction 2.2 Learning Outcome 2.3 Assessment Standards for the learning outcome **Chapter 3: Intermediate Phase (grades 4-6)** 3.1 Introduction 3.2 Learning Outcomes 2.3 Assessment Standards for	**Chapter 1 : Introduction** 1.1 Introducing the National Curriculum Statement a) OBE b) Revised NCS: LA statements c) Revised NCS: learning programmes d) Time allocation e) Assessment f) The Kind of Teacher that is Envisaged g) The Kind of Learner that is Envisaged 1.4 Introducing the Mathematicsy LA h) definition i) purpose j) unique features and scope: k) mathematics learning outcomes **Chapter 2: Foundation Phase (grades R-3)** 2.1 Introduction 2.2 Learning Outcomes 2.3 Assessment Standards for the each learning outcome **Chapter 3: Intermediate Phase (grades 6)** 3.1 Introduction 3.2 Learning Outcomes 2.3 Assessment Standards for each of the learning outcomes

	Chapter 3: Intermediate Phase (grades 4-6) 3.1 Introduction focus developing learners home language 3.2 Learning Outcomes 3.3 Assessment Standards and texts for each learning outcome **Chapter 4: Senior Phase (grades 7-9)** 4.1 Introduction focus Study Skills for Lifelong Learning 4.2 Learning Outcomes 4.3 Assessment Standards and texts for each learning outcome **Chapter 5: Learner Assessment** a) assessment principles used in OBE b) continuous assessment c) managing assessment d) keeping records e) reports **Reference Lists** Curriculum and Assessment Glossary Language Learning Area Glossary	introduction, learning outcomes, knowledge focus for each grade, assessment standards for each learning outcome **Chapter 3: Intermediate Phase (grades 4-6)** 3.1 History introduction, learning outcomes, knowledge focus for each grade, assessment standards for each learning outcome 3.2 Geography introduction, learning outcomes, knowledge focus for each grade, assessment standards for each learning outcome **Chapter 4: Senior Phase (grades 7-9)** 4.1 History introduction, learning outcomes, knowledge focus for each grade, assessment standards for each learning outcome 4.2 Geography introduction, learning outcomes, knowledge focus for each grade, assessment standards for each learning outcome **Chapter 5: Knowledge Focus Framework** Per grade **Chapter 6: Learner Assessment** a) assessment principles used in OBE b) continuous assessment	each of the learning outcomes **Chapter 4: Senior Phase (grades 7-9)** 4.1 Introduction 4.2 Learning Outcomes 4.3 Assessment Standards for each of the learning outcomes **Chapter 5: Learner Assessment** a) assessment principles used in OBE b) continuous assessment c) managing assessment d) keeping records e) reports **Reference Lists** Curriculum and Assessment Glossary Technology Learning Area Glossary	**Chapter 4: Senior Phase (grades 7-9)** 4.1 Introduction 4.2 Learning Outcomes 4.3 Assessment Standards for each of the learning outcomes **Chapter 5: Learner Assessment** a) assessment principles used in OBE b) continuous assessment c) managing assessment d) keeping records e) reports **Reference Lists** Curriculum and Assessment Glossary Mathematics Learning Area Glossary

		c) managing assessment d) keeping records e) reports **Reference Lists** Curriculum and Assessment Glossary Social Sciences Learning Area Glossary		

The above analysis shows that the learning areas followed the guidelines in the Roadmap Document- therefore only the Natural Science documents were analysed in depth.

Construct	RNCS- Natural Science
What is the structure of the policy document?	**Chapter1:** **1.1 Introducing the NCS** (generic for all learning areas) **1.2 Introducing the Natural Science Learning Area:** a) definition b) purpose c) unique features and scope d) natural sciences learning outcomes e) process skills across the three learning outcomes f) introducing the natural sciences assessment standards for each learning outcome **Chapter 2: Foundation Phase** (introduction, learning outcomes and assessment standards showing progression in each grade) **Chapter 3: Intermediate Phase** (introduction, learning outcomes and assessment standards showing progression in each grade) **Chapter 4: Senior Phase** (introduction, learning outcomes and assessment standards showing progression in each grade) **Chapter 5: Core Knowledge and Concepts** (grouped into four main content areas with themes in each content area specified per phase) **Chapter 6: Learner Assessment** (generic for all LAs) **Reference List** Curriculum and Assessment Glossary Natural Science Learning Area Glossary
Does the rationale make explicit:	The document explicitly states that the Natural Science Learning Area deals with the promotion of scientific literacy. It does this by: the development and use of science process skills in a variety of settings; the development and application of scientific knowledge and

	understanding; and appreciation of the relationships and responsibilities between science, society and the environment (p4).
Why the learning field is seen as important to include in the curriculum?	The Natural Sciences Learning Area differs from other learning areas because of: the way in which information is gathered and interpreted; the way in which information is verified before general acceptance; the acknowledgement of the limitations of scientific enquiry; and the domain of knowledge that is covered (four main content areas or knowledge strands: life and living, energy and change, planet earth and beyond, and matter and materials)[p5 and 6].
What constitutes the essential elements of the field?	The document explicitly states how each of the Learning Outcomes contribute to the development and meaning of the critical outcomes and developmental outcomes (p8). The document explicitly states that : meaningful education has to be learning-centred and help learners to understand not only scientific knowledge and how it is produced, but also the contextual environmental and global issues that are intertwined within the learning area (p5)
How are the outcomes defined?	Three learning outcomes
Is a value framework explicit in the statement of outcomes?	A strong humanistic, liberal, social redress orientation.

Appendix B: Content Summary and Analysis of C2005 Natural Science Policy Document

Content Summary according to the main themes and specific outcomes: Senior Phase

THEMES	PLANET EARTH AND BEYOND	LIFE AND LIVING	ENERGY AND CHANGE	MATTER AND MATERIALS
SCOPE STATEMENT	Earth's structure, dynamic features and components-from core to upper atmosphere-and the delicacy of the many environments associated with the Earth must be appreciated and understood at an appropriate level. A grasp of planet Earth's place in the universe can instill a sense of wonder and stimulate the imagination of learners. Within this theme, learning contexts should be drawn from under, on, above and beyond the Earth's surface.	Learners appreciate the dynamic interdependence between organisms and their environments; the forms of diversity that arises; and how the diversity can be explained as arising out of the interactions of organisms within their environments-which includes other organisms. It is important for learners to understand, at an appropriate level, how life processes are sustained and how these processes are affected by human activities and other factors. Within this theme learning contexts should be drawn from interactions within environments, diversity, change and continuity; and life processes and healthy living.	Concept of energy is fundamental to understanding both processes of change and life processes. Learners must understand at an appropriate level, how energy is transferred in biological and physical systems; the resultant changes-including movement as change-in those systems; and that successive energy transfers make less energy available for useful work. Learners must appreciate human needs and aspirations that affect choice of energy sources and the implication of those choices for the environment. Within this theme, learning contexts should be drawn from sources of energy, uses of energy; transfer of energy; and forces and movement as change.	The nature of matter and its properties-both physical and chemical-are fundamental to the physical universe and phenomena that occur in it. Products of human enterprise such as agriculture and mining may be enhanced using technologies and may result in materials useful to and even essential for learners' daily lives. Procuring and processing natural materials and the manufacture of synthetics are commercially important activities whose potential to impact on the environment must be appreciated. Within this theme, learning contexts should be drawn from the nature and properties of matter; change in matter and materials; production of natural and synthetic materials; and properties and uses of material.
SO1 Use process skills to investigate phenomena related to the Natural Sciences	Planetary motion and time, geological time-scale, mining, weather…..	Ecosystems, human body, plant and/or animal populations, plant physiology, relationship between structure and function…..	Force and movement, energy sources: renewability, availability, pollution….	Solubility, density, magnetism, electrical properties….

	PLANET EARTH AND BEYOND	**LIFE AND LIVING**	**ENERGY AND CHANGE**	**MATTER AND MATERIALS**
SO2 Demonstrate an understanding of concepts and principles, and constructed knowledge in the Natural Science	Key concepts such as land forms, galaxies, climate…..	Key concepts such as ecosystems, heredity, effect of environment on life processes, population dynamics	Key concepts such as force, heat, electricity, velocity, homeostasis….	Key concepts such as particulate nature of matter, chemical bonding, relationship between properties and uses of materials
SO3 Apply scientific knowledge and skills to problems in innovative ways	Effects over time of human activities on the earth's surface in South Africa, or elsewhere such as mining, farming….	Factors that affect life processes such as mining, farming……	Energy conservation or environmentally use and transformation of energy such as alternative energy sources: water, solar	Environmental impact of production and processing such as wool, synthetics, waste recycling….
SO4 Demonstrate and understanding of how scientific knowledge and skills contribute to management, development and utilization of natural and other resources	Resources in the earth, on the surface or beyond such as minerals, soil, solar energy, water catchment….	Life resources in South Africa but with wider relevance such as forests, biodiversity, food production, medicinal plants, wild life and domestic animals…..	Energy sources used in South Africa and outside such as coal, oil, hydro electric, nuclear	Resources used in building, manufacturing and processing such as synthetic products, metals, wood, natural fibres….
SO5 Use scientific knowledge and skills to support responsible decision making	Establish criteria for environmentally sensitive projects such as dams, town, industry….	Make judgements on actions affecting life and life-forms such as family planning, health, land-use for different types of farming purposes….	Decide on effective use and distribution of energy such as appropriate means of transport, energy distribution, conservation of energy….	Decide on most effective use of materials such as enrichment or export of raw materials, purpose cost and choice of materials, recycling….

	PLANET EARTH AND BEYOND	LIFE AND LIVING	ENERGY AND CHANGE	MATTER AND MATERIALS
SO6 Demonstrate knowledge and understanding of the relationship between science and culture	Scientific and cultural aspects of interests such as astronomy, geography, climate and weather	Scientific and cultural aspects of interest such as agriculture, health, medicinal plants and uses of animals…	Scientific and cultural aspects of interests such as solar energy, lightning….	Scientific and cultural interests such as design of houses, clothes, furniture and tools…
SO7 Demonstrate an understanding of the changing and contested nature of knowledge in the Natural Sciences	Theories such as the expansion of the universe, continental drift, ozone depletion….	Theories about the origin of species, heredity, embryonic development….	Theories such as atomic energy, relativity…	Theories such as on the particulate nature of matter, atom and molecule models…
SO8 Demonstrate knowledge and understanding of ethical issues, bias and inequities related to the Natural Sciences	Issues such as space exploration and its cost, global differences in resource allocation and availability…	Issues such as genetic manipulation, abortion, cloning, biodiversity, allocation of health care services….	Issues such as nuclear energy, allocation of funds for identification of energy sources….	Issues such as chemical warfare, priorities for research funding….
SO9 Demonstrate an understanding of the interaction between the Natural Sciences and socio-economic development	Devices such as satellites, mining, mineral extraction….	Processes such as production of antibiotics, drugs and food additives, bio-genetic engineering, in vitro fertilization…	Technological devices or appliances such as pulleys, gears, lifts, means of transport, generators, engines, hydro electric generators	Technological products such as time-pieces, photography, telecommunications, plastics, paints, paper…

Intermediate Phase: Science and Technology Combined

Four expected levels of performance stated without attaching content (conceptual knowledge).

Foundation Phase

The Natural Science Learning Area is not offered.

Appendix C: Content Analysis of the National Curriculum Statements for Natural Science (NCS- July 2001) for the GET Phase

Content Area: Life and living

Sub-themes	Interactions Within Environments			Life Processes			Biodiversity, continuity and change		
SO	*Investigating*	*Knowledge*	*Science and society*	Investigating	*Knowledge*	*Science and society*	*Investigating*	*Knowledge*	*Science and society*
Grade1	Relates animals and plants to each other	Relationships between living things	Plants and animals can be dangerous						
Grade 2				Needs of animals and plants					
Grade 3				A balanced diet			Changes in plants and animals		Cares for a plant or animal
Grade 4	Naming different organisms	Relationships between plants &/or animals &/or environments	Traditional uses of plants	Structure and function of teeth	The digestive system	-	Grouping plants and animals	-	-
Grade 5	Decomposition of vegetable matter	Food webs	Deforestation	Digestive diseases	-	-	Identifying and sorting organisms	Sorting plants and animals using binary classifications	-
Grade 6	-	Animal behaviour	-	What plants need; effects of smoking	-	Smoking and clean air	Growth of bread mould and mushrooms	Study of bread mould and mushrooms – structure, energy, place in food web	-
Grade 7	Dispersal of seeds	-	-	Life cycle of a small animal	Sexual and asexual reproduction	Responsible sex	Endangered species; inheritance in humans	Endangered species	-
Grade 8	Pollution	-	Pollution	Plants as human food	-	-	-	Inherited characteristics	-
Grade 9	Human activity and its effects on env; sustainability of medicinal plants and animals	-	-	Exercise and health	Effects of drugs on body function	Medicines from plants and animals	Breeding plants	Cattle/sheep breeding	Breeding, farming and biodiversity; Alternative medicines

Content Area: Energy and Change

Sub themes	Energy transfers, systems			Energy and responsible development					
SO	*Investigating*	*Knowledge*	*Science and society*	Investigating	*Knowledge*	*Science and society*			
Grade 1									
Grade 2									
Grade 3									
Grade 4	Describes energy transfers and changes	Sequences connected events as energy transfers	Appliances that make life easier	-	Energy sources, systems, and 'useful work'	-			
Grade 5	Builds an energy receiver or transfer system	Describes interactions between parts of a system	-	-	-	Appliances and energy sources in different communities			
Grade 6	Builds an electrical system	Identifies chains of energy transfer	-	-	-	Sources of energy and their accessibility for different communities			
Grade 7	Investigates a transfer system	Uses energy terms, forms of energy	-	Investigates costs of energy for cooking	Renewable and non-renewable energy resources; energy chains in (eg) electric supply	-			
Grade 8	Investigates factors that affect the performance of a system	Explains energy transfer, through working, heating; relates energy to change	-	-	Ways of conserving energy resources	Costs of energy – in money and to the env			
Grade 9	Investigates relationships between variables in an energy system	Describes energy transfer in electric circuits, chemical reactions, gravity, respiration, heating	-	-	-	Energy costs, alternatives and conservation			

Content Area : Planet Earth and Beyond

Sub themes	Atmosphere			Changing Earth			Space		
SO	*Investigating*	*Knowledge*	*Science and society*	**Investigating**	*Knowledge*	*Science and society*	*Investigating*	*Knowledge*	*Science and society*
Grade 1									
Grade 2	Weather and seasons								
Grade 3	Recording sun and cloud		Weather affects us		Describing position				Ideas about moon, sun, stars
Grade 4	Describes weather	Records weather	-	Classifies soils	-	Soils and people	Phases of the moon	Phases of moon	Myths about the moon
Grade 5	Water cycle	Air is gas	The value of water; Living with seasonal changes	-	Water and water movement	Clay pots to store water	Sun's motion – days and seasons	Sun's 'motion' and its effects on life	Myths about the Sun
Grade 6	-	-	-	Features of fossils	Fossils, and the evolving earth	-	The Earth as a spinning sphere; space exploration	-	Space exploration and technology
Grade 7	Weather measurements	Regional weather and seasons	Forecasting the weather	-	Human origins	-	The solar system	The solar system	Space exploration and technology
Grade 8	-	-	-	Internal structure of the Earth	The earth's crust	-	-	-	Explanations and uses of astronomical phenomena by different cultures
Grade 9	-	-	-	Metal and mineral extraction	-	-	Star maps	Sun-Earth-Moon relationships; features of the solar system	Worldwide cooperation in space science

Content Area: Matter and Materials

Sub themes	Properties and uses			Structure, reactions and change		
SO	*Investigating*	*Knowledge*	*Science and society*	**Investigating**	*Knowledge*	*Science and society*
Grade 1	Mixes/changes materials	Sorting materials				
Grade 2	Properties: sinking and floating					
Grade 3	Magnets			Structures of different materials	Relates properties to uses	Traditional uses of materials
Grade 4	Choosing materials for particular purposes	Ways in which materials are used	Materials used in local industries; problems of waste materials	Reversible and irreversible reactions – eg dissolution, melting	-	-
Grade 5	-	How common (manmade) materials are made	Work opportunities arising from use of materials	Visible structure and properties (wood, soil, etc)	-	-
Grade 6	Creating materials with new properties	Materials in familiar objects	Materials for buildings/construction	-	-	Ways of preserving foods
Grade 7	Measuring properties and comparing materials	Properties and their relationships with uses	Materials produced in local industries; problems of waste materials	Acids and bases	-	-
Grade 8	Choosing materials as part of design	Solubility	-	Chemical reactions and word equations	Particle model and phases of matter	Uses of chemical interactions in different cultures
Grade 9	-	-	The costs of mining	Chemical reactions; acids, bases and metals	-	-

Appendix D: Content Analysis of the Revised National Curriculum Statements for Natural Science GET phase (RNCS)

Content Area: Life and living

Sub-themes	Interactions Within Environments	Life Processes and Healthy Living	Biodiversity, continuity and change
Unifying Statement	**Organisms in ecosystems are dependent for their survival on the presence of abiotic factors and on their relationship with other organisms**	**Living things, including humans and invisibly small organisms, can be understood in terms of life processes, functional units and systems.**	**The huge diversity of forms of life can be understood in terms of history of change in environments and in characteristics of plants and animals throughout the world over millions of years.**
Foundation Phase	*Dependence of humans on plants and animals for food, breeding certain animals, growing plants as crops *Cultural diversity in the kinds of food people eat *Germ carrying animals like flies and ticks that make people sick	*Corresponding parts of human body (limbs, head, eyes, ears, feet) with animals and similar purposes they serve. *Needs of animal and plants for food, water and air similar to humans	*Visible differences in a variety of plants and animals Grouping of plants and animals by their similarities *Change in plants and animals as a result of growth, time and as seasons change
Intermediate Phase	*Dependence of animals on green plants for food. *Concept of ecosystem, life and reproduction of all organisms in an ecosystem depend on continuing growth and reproduction of plants *Concept of habitat, social patterns of animals in their habitat *ecosystems and dependence on soil *role of water in ecosystems	*green plants produce their own food, requirements *importance of food for living things, balanced diet in humans *living things responding to their environment using specialized sense organs *movement of living things	* concept of vegetative reproduction *concept of sexual reproduction * diversity of life from fossil records
Senior Phase	*human reproduction involving judgement and value *Characteristic behavior of animals related to feeding, mating, raising a young, living in a population *adaptations of organisms to habitat *foob webs, ecosystem with biodiversity, sustainable development *pollution *biological changes e.g., recycling, decomposition, diseases caused by small, quickly reproducing organisms	*Physical changes during human reproduction, puberty, process of fertilization, prevention of sexually transmitted diseases *photosynthesis in green plants that provides food for the survival of other organisms. *animal systems: digestive, circulatory, respiratory, excretory.	*variation in species *natural selection *biological characterization as a social construct *biodiversity and classification- two main categories of animals: Vertebrates (5 classes) and invertebrates. * human activity that results in a loss in biodiversity *extinction *the cell

Content Area : Energy and Change

Sub themes	Energy Transfers and Systems	Energy and Development in South Africa
Unifying statement	**Energy is transferred through biological or physical systems, from energy sources. With each energy transfer, some of the energy becomes less available for our use, and therefore we need to know how to control energy transfers**	**Energy is available from a limited number of sources, and the sustainable development of countries in our region depends on the wise use of energy sources**
Foundation Phase	*concept of energy: to move fast, or do a lot of work	*insufficient energy/right kind of food results in tiredness and lack of energy
Intermediate Phase	*sources of energy *systems and energy transfer *designing systems to store energy *electrical circuit *changes associated with loss/gain of energy *sound energy through vibrations	*source of energy for humans and animals *safety rules for electrical energy
Senior Phase	*energy stored in systems *potential energy converted to kinetic energy in a system *unlimited number of systems that store/transfer energy e.g., electrical, mechanical etc *energy wastage by physical systems *energy transfer and heat *energy transfer in an ecosystem *light and energy transfer *force and energy transfer	*renewable and non-renewable energy sources *development and poverty relief -electrical energy supply *large scale electrical energy supply and environmental implications *other electricity-generation systems with smaller environmental impact *managing renewable energy sources in rural communities.

Content Area : Planet Earth and Beyond

Sub themes	Our Place in Space	Atmosphere and Weather	The Changing Earth
Unifying Statement	**Our planet is a small part of a vast solar system in an immense galaxy**	**The atmosphere is a system which interacts with the land, lakes and oceans and which transfers energy and water from place to place.**	**The Earth is composed of materials which are continually being changed by forces on and under the surface.**
Foundation Phase	*observation of different objects in the sky. All objects have properties, locations and movements which can be investigated to determine patterns, trends and relationships.	*weather changes, recording and prediction, impact on people's lives	*variation in soil and rocks, erosion
Intermediate Phase	*explanation of day and night *shape, position of moon, associated cultural traditions *stars position in relation to each other, cultural recognition and naming of star patterns and uses in navigation and calendars.	*weather changes: temperature, wind direction and speed, and precipitation *medium term change- annual seasonable change *water cycle – changes in water between hydrosphere, lithosphere and atmosphere *amount of water and land available to humans on the planet	*earth materials *erosion and landforms *classification of rocks *composition of soil *fossils *quality of water resources
Senior Phase	*the earth in relation to other planets *motions of earth and moon *gravity *sun as the major source of energy	*layers of the earth *variation in climate in different parts of the globe *the atmosphere and gas composition *atmosphere protects the earth *changing composition and temperatures of the atmosphere due to human activities and natural events	*layered structure of the earth *Lithospheric plates *landforms *fossil records as evidence of the changing earth *fossil fuels *mining industry and legislation regarding safety and environmental effects

Appendix E: Strands – The Organisation of Content in A Statement of science for Australian Schools for 10 years of compulsory Schooling (p14-35).

The content of the science curriculum is organized in five strands: one process strand and four conceptual stands. The conceptual strands reflect the traditional organizations of science into the distinct areas of biology, chemistry, earth sciences and physics (p14-A statement of science for Australian Schools).

Ideas within strands across levels

Each organizer in the profile is based on a unifying idea, which is developed progressively through the eight levels. These are shown in the table below, along with examples of content in the organizer.

Strand	Organiser	Unifying Idea	Examples of Content
Earth and Beyond	Earth, sky and people	Our lives depend on air, water and materials from the ground; the ways we depend on landscape, weather and climate	Management and use of earth materials, earth formations, weather, climate, catastrophic events
	The changing Earth	The Earth is composed of materials that are altered by forces within and upon its surface	Origin of rocks, minerals and soil, features of physical environment, geological processes, weathering, evolution of the Earth, plate tectonics
	Our place in space	The Earth and life on Earth are part of an immense system called the universe	Solar system, day and night, seasons; stars, galaxies and constellations, stellar evolution, space travel
Energy and Change	Energy and us	Energy is vital to our existence and quality of life as individuals and as a society	Renewable and non-renewable sources, patterns of energy use, energy transformations
	Transferring energy	Interaction and change involve energy transfers; control of energy transfer enables particular changes to be achieved	Change and interaction, processes of energy transfer; machines, circuits, optics and other transfer systems; force, work and power
	Energy Sources and receivers	Observed change in an object or system is indicated by the form and amount of energy transferred to or from it.	Forms of energy and the changes they relate to, principles of energy conservation and efficiency
Life and Living	Living together	Organisms in particular environment are interdependent	Ecosystems, interrelationships, energy and matter cycles
	Structure and Function	Living things can be understood in terms of functional units and systems	Functional systems and units, life processes and organization
	Biodiversity, change and continuity	Life on Earth has a history of change and disruption, yet continues from generation to generation	Life cycles, classification, inheritance, reproduction, evolution, extinction.
Natural and Processed Materials	Materials and their uses	The properties of materials determines their uses; properties can be modified.	Uses and properties of materials, altering materials, making materials.
	Structure and Properties	The substructure of materials determines their behavior and properties.	Structure and behaviour of matter, elements, compounds and mixtures, particle theories of matter.
	Reactions and change	Patterns of interaction of materials enable us to	Physical and chemical changes, factors

		understand and control these interactions	affecting rates of change, conservation of matter, manufacturing processes
Working Scientifically	Planning investigations	Working Scientifically is a powerful way of generating understanding and solving problems	Analyzing a situation, defining questions and goals, proposing explanations and solutions, designing tests, considering limitations.
	Conducting investigations		Carrying out procedures, using equipment, observing, gathering information, recording and reporting results.
	Processing data		Interpreting observations, seeing ramifications, identifying patterns, forming generalizations, drawing conclusions, considering accuracy and reliability.
	Evaluating findings		Relating findings to other situations, suggesting improvements to plans, assessing whether purposes have been achieved, relating conclusion to other knowledge.
	Using science		Generating understanding, making connections, explaining, applying ideas and skills; solving problems.
	Acting responsibly		Taking responsible action using science information and skills

Process and Content Analysis (from a statement of science for Australian Schools)

Strands/Bands	Working Scientifically	Earth and Beyond	Energy and Change	Life and Living	Natural and Processed Materials
Band A (lower primary years of schooling)	*students express own ideas, make guesses, listen to others explanations *posing questions, plan and carry out investigations *making predictions and hypothesis *observe and make measurements *presenting findings *talk about limitations of investigations *build vocabulary of scientific terms, develop skills and processes *how can they contribute to the environment *how local people use scientific processes and knowledge	*list of features of their local landscapes and other localities *undertake projects in which they explore relationships between the ways people live and the environment *landforms, rocks and soil *Texture and composition of soil *changes in environment- day and night, seasons, weather *compare environment now with past *plants and animals respond to and live with environmental changes *making instruments to measure weather, looking for patterns *sun, importance, movement of sun as seen from earth, sun's position to time of day	*energy transfer and change around them *making musical instruments to investigate ways in which pitch and loudness can be controlled *reflections from flat and curved mirrors and mirrors placed together, survey uses of different kinds of mirrors in their homes and shopping centers *effects on sunlight on skin, temperature of road, plants *motion and speeding up motion *energy sources and purposes, energy transfers, energy conservation	*discover existence of a variety of living things *names of living things and their parts, sorting, caring *stages of growth, development, death of animals- similarities of offspring to parents *exploring natural and built places *relationship between living things, caring for the environment	*variety of materials and their uses *describing substances in terms of shape, colour, texture, size *explore behavior of liquids *ask members of community about materials used in particular applications *comparing properties of material and designing experiments *examine substructures of soil, powders, particleboard *modify properties of substances *investigating what happens to substances under different conditions

Strands/ Bands	Working Scientifically	Earth and Beyond	Energy and Change	Life and Living	Natural and Processed Materials
Band B (upper primary years of schooling)	*find out about simple everyday problems that are relevant to them. *examine the practice of science in different cultural contexts and consider how it affects peoples personal lives, work and leisure *investigate work in the community involving the use of science and speculate about the social, cultural, technological , economic and environmental impact of scientific applications, findings are published, assembly talks, community activities *use science to improve quality of the environment, seek information from professional scientists and community members on issues like pollution, health, shelter *recognize contribution of people to science-study lives and times of men and women scientists and contexts under which they worked, value and recognize logical reasoning and fairness *pose problems they like to solve in their immediate environment, follow up on hunches and generate new or alternative ideas. *make predictions and hypothesis they can test, exploring the idea of controlling variables *conduct investigations using apparatus for storing, transferring, mixing and heating substances and manipulate equipment involving electricity, light and sound, make rules to ensure safe use of equipment *make orderly and sensible presentations of their findings to a	*investigate their local environment to assess the impact of human activities on the surface features of the land. *consider how to monitor, modify and control the long term effects of these changes *recognize the importance of exploration and investigation of the Earth and universe *collect information about historical explorations and comment on benefits by scientists, consider developments such as radio telescopes, space probes and stations *identify visible locations of the effects of natural processes such as erosion, flooding, weathering, deposition, glaciation *find out about the movement of tides, the effects of wave action on coastlines and ways coastlines are protected. *study soil and recognize the importance of maintaining soil quality *develop knowledge of the various potentially catastrophic natural phenomena are monitored and investigated to avoid disasters- consider earthquakes, volcanoes, cyclones, floods and investigate instruments used to monitor, how data reveals patterns and future predictions *use a variety of sources to develop presentation on topical issues such as the impact of the greenhouse gas emissions *find out about features such as volcanoes, craters, earthquakes, icecaps, stalactites, oceans, the stratosphere and ionosphere, holes in the ozone layer,	*energy transfer as a means of causing and explaining change *analyse interactions around them to identify energy sources, receivers, transfers *design an elaborate mousetrap/burglar alarm, role play the operation of an automatic boom gate in a hospital parking lot *classify mechanisms of energy transfer *devices that impede energy transfer *importance of energy in our lives, conduct energy surveys in their homes, the school and the community and propose ways to reduce wastage *learning occurs in the context of technology and problem solving *dismantle common devices and examine how they work *design ways to light dark corners, improve the acoustics of the school hall, reduce costs of waste disposal *qualitatively compare different machines used for particular purposes- egg whisks against egg beaters, microwave against electric ovens – begin to understand	*study plants and animals in local habitats, aquarium, in the school grounds, map food chains and web and discuss the interrelationship evident *conduct investigations on the interaction of the environment with living things e.g., factors affecting seed germination *recognize sun as source of energy for life *monitor and record information of how living things go about their lives *prepare a case study on the positive and negative effects of introduced animals and plants on native animals and plants *explore effects of humans on the environment *examine internal and external parts of plants and animals using microscopes, fieldglasses and hand lenses and their function *describe features of these structures *observe living things such as insects, shellfish, shrubs and trees and identify similarities and differences in structure	*students make stronger bridges, paper planes that fly higher by changing composition and shape of materials *design and carry out tests to compare and measure properties of materials as strength, flexibility, conductivity, solubility and relate this to their uses. *use equipment like balances and rulers, importance, find out about the uses of various materials by asking people like artists, carpenters etc *use microscope or hand lenses to examine materials visible substructures such as fibres and grains and arrangement for flexibility and strength *investigate relative strengths of materials shaped in different ways e.g., rope, yarn, paper *role play the behaviors of particles in solid, liquid and gases and describe some of their distinctive behaviors- use a model to show particle nature of matter *changes of state, ways materials change in a

	wide range of audiences(classmates, teachers, parents) using diagrams, charts, tables, graphs, symbols, computer printouts and models *make inferences and review ideas in light of results	smog, fog, galaxies and black holes. *build models to illustrate phenomena such as volcanoes, craters and consider how information from studying these natural features reveals more about the internal structure of the earth *use models, simulations, role-playing and other representations to illustrate the spatial relationship of the sun, earth, moon and use these to explain eclipses, day and night, phases of the moon and seasons. Relate the passing of time to the relative movement of the earth around the sun and the moon around the earth and the rotation of the earth about its axis. *way cultures have used these movements as significant indicators of events in their lives. *sun as a source of energy for air currents and other weather patterns *observe night sky and identify major planets and stars and constellations *report on conditions on planets and conditions that sustain life *distance and position of planets, requirements to make such a journey	the idea of efficiency	and the way they are adapted to their habitats *classification *different structures and systems working together e.g., how water is transported in plants *examine fossil to investigate how life on earth has changed, adaptation *extinction and ways of conserving endangered species	variety of situations *separate mixtures to ascertain composition *reversible and irreversible change *study manufacturing processes e.g., turning cream into butter, cooking, processing of fibres and sewage treatments *explore notion of costs and benefits *use, storage, recycling and disposal of materials in local contexts such as home, shopping center, local factory *safety in storing and mixing materials

Strands/ Bands	Working Scientifically	Earth and Beyond	Energy and Change	Life and Living	Natural and Processed Materials
Band C (lower secondary years of schooling)	*individually or in groups become more methodical and precise with measurements, to be critical minded and skeptical about evidence, be aware of the provisional nature of knowledge and take into account ethical and social considerations. *pose questions, seek out information, identify testable and falsifiable hypotheses that enable them to make predictions *design, carry out and report on investigations involving dependent and independent variables. *manipulate variables and use suitable sampling and statistical techniques *recording findings using scientific and mathematical conventions *evaluate investigations, suggest alternatives, produce structured reports, including analysis of results and discussion of implications of findings *when working in groups they negotiate roles, suggest alternative ways to proceed. Their planning takes in design, data collection, equipment and analysis, and sensitivity to purposes, validity and reliability	*explore structure and evolution of the earth in order to understand its variety and formation and the ways humans use Earth Sciences for their purposes of building cities, farming the oceans, mining, tackling salination , planning underground railways and tunnels, or choosing sites for dams or routes for highways *examine rocks and landforms in their local environment and classify them according to their origin. *soil formation *cycling and transformation of materials over time *scientific principles of alternative techniques in mining, framing and conservation *undertake detailed case studies on management of resources and effects of human activities on the environment. *explore critical relationships between social, political and economic factors in society and the work of scientists. *origins and structure of the earth-theories of the relationship of the Australian continent to Asia, Antarctica and America, and discuss the use of ideas of continental drift. They prepare reports, posters and models on the structure of the earth and present evidence	*move towards a quantitative use of the ideas of energy and change developed in Band B *come to understand principles of energy conservation and work-energy, and develop expressions for some common energy forms. *sometimes they learn in context of technology and social issues, sometimes in the context of building and understanding a scientific theory *recognize complications that have to be accommodated in the theory *investigate simple machines such as pulleys, levers and hydraulic systems and compare work input and output *extend to more complicated systems like geared bicycles and combination of pulleys *work and energy and expressions for changes in energy/work through experiments to see difficulties in managing energy losses and inefficiencies in energy transformation and transfers. *developing understanding of energy in the context of building a scientific theory but learning occurs in	*investigate local environments and analyse relationships in food webs *distinguish between producers, consumers, decomposers and discuss their role *trace the passage of carbon, oxygen and water and recognize the significant role of living things in sustaining these pathway *examine modification of natural systems and monitor effects of environmental changes on living things. *discuss ways different cultural groups manage their environments and evaluate alternative means of sustaining ecological development *using microscopes and published information, investigate cells from various plants and animals identifying common microscopic structures that aid life processes, make connections between organization at the cellular level and at the systems level. *investigate the major life sustaining processes such as respiration, nutrition, photosynthesis. These ideas may be explored in the context of general understanding or in context of health and life-support in technologies such as kidney dialysis or permaculture	*focus shifts to chemical properties and progress made in simplifying, ordering and understanding millions of chemicals and their actions through the theory of atoms. *explore issues arising from the capacity of our society to create and use a wide range of materials and from accompanying hunger the society has for materials of all kinds. *identify classes of chemical reaction-combustion, corrosion, oxidation-reduction, acid-metal, acid base, explore characteristics and effects *investigate factors that influence rate of reaction and consider for example, ways to inhibit rusting, preserve food or control the body's rate of absorption of medicine. *use a variety of indicators, test their own and commercial indicators on shampoos and other household products and look at the effects. *experiment with ways to produce some chemicals and separate and analyse others, synthesize face creams and mayonnaise, extract perfumes and esters, measure the iron in breakfast cereals. *visit to local industries to find out about industrial

	*take account of science's potential to solve practical problems *scientific information and methods are discussed in relation to environmental, religious, social, legal and economic viewpoints. Consider intended and unintended consequences of action *examine topics as diverse as desalination, organ transplant, genetic counseling, high speed trains and become directly involved in projects *communicate to a range of people, in a range of forms about these matters *students increasingly reflect on and evaluate their own understanding and purposes, using them for planning their own further learning. *explore the history of the development of scientific concepts to understand the evolving nature of knowledge and the way it is generated *find out about work of scientists in the community.	to support these theories, including evidence of continental drift. *question life on other planets and examine characteristics on earth favourable to sustain life, reflecting on the place of humans in the universe *construct a possible timeline for the life and death of our sun and discuss the consequences for earth *pose questions about the evolution of the universe that link up with their studies of the history of the earth * report on evolution of stars and techniques that have enabled scientists to have formed these theories *consider the use of inference and triangulation as part of observation and theory – building. *focus on recent experiences of humans in the hostile environment of spaceships, the moon and space stations. *examine issues in the conduct and future of such expeditions, and look at spin-offs from space research.	technological and social contexts e.g., design an energy system for a remote community, cost-benefit or social issues in global energy use, the ways that scientists estimate energy reserves, the interactions during the industrial revolution and now between the development of energy theories and energy technologies. *an introduction to Newton's conception of forces as a way to understand interactions, concept of working as a way to transfer energy (forces : pushes, pulls, gravity, springs) extend to ideas of friction, dissipation of energy, balanced and unbalanced forces and effects of forces in motion *waves as a means of transferring energy, focus on electromagnetic waves and their use in communication.	*explore relationships and interactions to appreciate that living systems are integrated and that feedback mechanisms are essential to maintain equilibrium. *relate their understanding to techniques of human intervention in life processes-some students complete projects in this area *trace the historical development of our understanding of cells, reporting on contributions of past and present women and men scientists. *identify major features of significance in adaptation and in enabling animals and plants to compete successfully in their environments through studying living things in a zoo or aquarium *illustrate the survival benefits of various adaptations of exotic plants and animals. *study the vast range of adaptations, including behavioral adaptations to gain an appreciation of diversity.	methods and examine the important economic, environmental and social factors. *some students might conduct cost-benefit analyses or impact studies of particular processes or competing products and processes, some will go on to consider issues in world demand for materials and the role that scientists play in these developments. *knowledge of atoms and ways that theories of atoms and molecules can explain elements and compounds, chemical reactions, solids, liquids and gases. *apply simple ideas of atoms to families of substances, like metals and alloys, acids, oxides, gases, solution in water *complete projects and trace key events and people such as Aristotle, Franklin etc and today's scientists. *look at application in other fields of the idea that we can understand something by identifying and understanding its substructure, seeking to assess the pros and cons of this approach within science and outside it.

Content Area: Matter and Materials

Sub themes	Properties and uses	Structure, reactions and change
Unifying Statement	**We can classify materials by their properties, in order to establish types and patterns. Properties determine the selection of materials for particular uses.**	**We can modify materials in ways that we choose, through our understanding of the sub-structure**
Foundation Phase	*classification of materials by their properties of texture, colour, strength, heaviness	*Changes observed when substances are mixed
Intermediate Phase	*pure substances *classification of materials by their properties e.g., hardness, flexibility, thermal conductivity or insulation, electrical conductivity or insulation, magnetized, solubility and rusting) *major classes of materials	*temporary and permanent changes to materials *heat and substance change *variables affecting rate of dissolving
Senior Phase	*properties of substances in different states *dark and light coloured surfaces in relation to heat *materials that can become magnetized and electrically charged *conductors and resistors *separation of mixtures *production of certain gases *extracting useful materials by chemical reactions and methods of separation *raw materials- mining and growing	*particle model of matter to explain physical changes of substances *Acids, bases, indicators *activation energy for chemical reactions *elements, compounds, energy *reactions of oxygen with metals and non-metals *reaction of oxygen with food releases energy in cells of living things.

Appendix F

Interview Schedule

Dear Colleague (involved in Curriculum 2005/NSC)

Thank you for consenting to be interviewed for this study. I have no doubt that the contribution you will make will significantly advance this study. In this interview I wish to hear about the science curriculum development process for Curriculum 2005/NSC as you have experienced it. I intend to ask questions around the policy-making process and nature and content of science. I do not intend to impose any particular structure to this interview, so please speak freely. In order to guide the discussion, below are a few questions I will focus on.

Questions

A. For both C2005 and NCS

<u>General pressures on the curriculum:</u>

1. Where did the major pressures for rethinking the science curriculum come from?

    <u>Particular problems or issues</u>
    >other policy documents?
    >new theoretical insights into the most appropriate ways of teaching and learning in relation to complex goals?
    >Broad vision embodied in the White Paper on Education and Training?

2. It is sometimes claimed that the 'science curriculum reflects the concerns of university academics/ experts involved in the process rather than students and the community'. How do you feel about this?

3. "Science for all" is widely proclaimed as a policy goal, and perhaps has particular meanings in South Africa. In what ways was the goal of 'science for all' important? What did it mean?

The Process

4. In this question I am interested in the role you played in policy before you became involved in the process?
   >were you a critic of the state and its workings?
   >a reformer?
   >activist/ researcher?

5. How was you role defined in the committee?
   >what were the specific responsibilities you were tasked with?
   >were you sufficiently resourced, empowered and skilled to fulfill your task?

6. How was the policy-making process for Curriculum 2005 structured and what did you see as possible strengths and weaknesses to this kind of arrangement?
   > core group from the NS LAC, 5 Curriculum Co-ordinating Committees, Technical Committee, assisted by reference group (3 from each LAC and two teachers from each LAC)

   In what ways did the process give voice to learners and parents that were not represented in the process?
   >was there a broader consultation process, public submissions? Did that consultation reach all people/groups?

7. What were some of the political and practical issues/tensions that were important for the committee during and after the process?
   >the influence of Spady and other overseas groups such as the Canadian team in defining C2005?
   >tensions in defining 'science for all' (which all, who decides.....)
   >did the committee wish to be innovative and walk alone?
   >was the committee constrained by the political process of decision- making, influence, power?
   >constraints of higher policies and bureaucratic requirements and frameworks?

8. What kinds of groupings came to be established which aligned/separated different individuals during the policy-making process?

Theoretical Issues

9. What were some of the conceptual and theoretical conflicts/ compromises that were important for the committee during and after the process?
   >*breadth and depth,*
   >*inclusion of indigenous knowledge system,*
   - ➢ *assessment and accountability*
   - ➢ *policy vs implementation*

10. To write outcomes, assessment standards and invent progression levels is an intellectually demanding task. How did the committee do about it? What were some of the key challenges the committee faced in writing the policy document?

11. Did the committee develop in any systematic way an organizing framework for the documents e.g., finding agreement on a rationale, perspectives on science and learning?
    >*in deciding on purposes, outcomes, content, assessment standards?*
    >*where there competing interests and opinions in these discussions and how were they resolved?*
    >*how were tensions between liberal and instrumental purposes, oversees trends vs locally defined needs resolved?*

13 On what basis were decisions about the choice of content made?
>*what problems did you experience in deciding on the disciplines?*
>*how much was drawn from external sources e.g., US Project 2061*
>*where there struggles in defining a truly African science curriculum?*
>*has there been a major shift from international trends?/ previous process?*

14. One of the discourses that is presently receiving much attention in scientific circles is that of 'scientific argumentation' in developing higher order reasoning skills in science. Such skills align with the critical outcomes of the NQF. How did the committee work through the incorporation of the critical outcomes and higher order thinking skills as part of curriculum 2005?

15. Was there much discussion on sensitivity to societal issues of poverty, inequality, HIV/AIDS? How have these concerns played out in the final policy document?

16. One of the expectations of C2005 was that it should define outcomes tightly enough to claim a common curriculum for all, but loosely enough to enable local variations. Was this tension important as part of the writing process? How did the committee seek to resolve it?

17. What was the nature of the discussion around the nature of science and science knowledge and content?
    >*science and its relation to culture*
    >*problematic nature of scientific knowledge*
    >*responsible use of science, ethics*
    >*multi-culturalism, pluralism with orientation to philosophy, applications, social responsibility*

18. How would you respond to the comment made by Jansen in his book: 'Implementing Education Policies' that policies (C2005 being one of them) produced in the 1994-1997 period were highly sophisticated and merely symbolic or visionary rather than being intended to bring about any fundamental change in classrooms? Did the committee discuss the tension between a visionary symbolic policy and a practical implementable one?

B. Additional questions for the Departmental officials involved in C2005 and NCS.

1. I see that you have been involved in more than one phase of the policy-making process.
    >*where there continuities in the composition of the committee?*
    >*where there certain individuals and interests that you think were deliberately excluded from the continued process? Why?*

2. In 1999, the Gauteng Institute for Curriculum Development produced an alternative to C2005, borrowed from the Australian Profiles. This was ignored by the NDE at the time but seems to have strongly influenced the latest NCS. Do you feel that this is so? If yes/no why? In what ways has it been important/ not important?

3. Curriculum design in the learning areas occurs within a framework of overarching policies, frameworks and management processes. These can be construed as constraints, or as guidance. What were the processes and frameworks that you feel, with hindsight, served as unhelpful constraints? As helpful guidelines?

C. NCS

1. In terms of streamlining the design of C2005, what did this mean for the committee in the ways in which content was defined?
>what was the brief from the review committee?
>how did the committee interpret this brief?

2. The 2001 version of the NCS was widely criticized as retreating from the vision of C2005 to a narrowly defined science, syllabus strategy and mastery learning? Do you think this is a valid critique? What were the influences that led to the changes in the 2002 version?

3. The 2002 version of the NCS is vastly different from the 2001 version. Were the personnel who produced the 2002 version much the same as those involved in the 2001 version? What led to such a different document being produced?

D REVIEW COMMITTEE

1. The design brief for the Review Committee and the recommendations of the review committee were well documented. What were some of the key criticisms that were made in relation to science in particular?

2. The Review process included discussions with the development team for science on 12/04/2002. What criticisms and guidance did the team have/offer in terms of:
>science content
>science processes, skills
>science values
>the policy-making process?

3. What were some of the political and practical tensions that were important for the committee during and after the process?
>how influential were empirical field evidence?
>was the committee constrained by the political process of decision- making, influence, power?

>higher policies and bureaucratic requirements and frameworks?

4. What were some of the conceptual and theoretical conflicts/ compromises that were important for the committee during and after the process?

5. In terms of specifying the curriculum requirements at various levels and phases what did you see as possible strengths and weaknesses to this kind of arrangement?
>flexibility of the curriculum?
>level of preparedness of teachers?

6. The term 'streamlining' was attractive, but ambiguous in that it was not clear whether streamlining meant staying close to C2005 or changing it significantly? What did it mean for the content of science?
>where the big ideas of science to remain?
>what was to be excluded/included? Why?

E. MINISTERIAL PROJECT COMMITTEE AND MENTORS

1. What was the nature of the recommendations around the structure of the policy making process and the policy environment.
>what were the strengths and limitations of the C2005 arrangement?
>what were the recommendations in terms of composition and selection of the committee?

Appendix G

Po Box 43916
Port Shepstone
4240

03 June 2002

Dear Colleague

I wish to place on record my sincere thanks and appreciation to you for volunteering your kind assistance with the research being undertaken into the analysis of the science curriculum development process. I also wish to guarantee that the information you supply will be treated with absolute confidentiality. This information will be used for research purposes only.

The study that I am embarking on traces the development of the Natural Science Curriculum over four unique periods: pre-1994, the syllabus revision process (NETF process), Curriculum 2005, and the National Curriculum Statements (2001 and 2002 versions). You have been identified as one of the policy-makers involved in conceptualising and formulating the policy documents for one or more of these periods. I am interested in how you have perceived the policy-making process and your personal views on the nature of science and science learning. The data collection method that I am employing is a questionnaire to capture base-line data and a follow up interview. I would appreciate it if you would complete this questionnaire for me and mail it electronically or I will contact you telephonically regarding the return of the questionnaire and arrangement for the interview that would be most suitable for you.

In conclusion may I add that your assistance in this research will not only be sincerely appreciated by me but will, I hope, make a contribution to the policy development process.

Kind Regards,

A. Ramsuran
Phd Student
University of Durban Westville

QUESTIONNAIRE

PREFACE: The purpose of this questionnaire is to collect information about the role of you as a policymaker tasked with the development, conceptualization and formulation of the natural science curriculum. Please be assured that the information you supply will be treated with absolute confidentiality and will be used for research purposes only.

PART A

[redacted]

PLEASE FILL IN OR CROSS (X) THE APPROPRIATE OPTION

1. What was your profession at the time of your being on the task team at the National/Provincial level, to formulate the natural science curriculum?

Subject Advisor	Science Educator at school	University lecturer/scientist	Department Official	Other (specify)
1	2	3	4	5

2. Main teaching subject area or area of expertise

Natural Science	Botany	Zoology	Physics/chemistry	Physiology	Biology
1	2	3	4	5	6

Earth Science	Environmental Science	Phase specialist	Other (specify)
7	8	9	10

3. Level of schooling in which you are interested / involved at?

Foundation phase (grades 1-3)	Intermediate Phase (grades 4-6)	Senior Phase (grades 7-9)	FET phase (grades 10-12)	Tertiary Sector
1	2	3	4	5

4. Experience of curriculum development at policy level in years.

0-5	6-10	11-15	16-20	More than 20
1	2	3	4	5

5. Gender

Male	Female
1	2

6. Experience in completed years of teaching science at school level.

Under 10	11-15	16-20	Over 20
1	2	3	4

7. Formal qualifications (completed) with specialisation.

8. If you represented an interest group/ organisation during the time of your involvement in developing natural science policy, which organisation and where is your organisation located?

9. Which organization/institution are you presently at?

PART B

[redacted]

PLEASE FILL IN OR CROSS (X) THE APPROPRIATE OPTION.

1. **In which period(s) were you involved in developing the Natural Science Curriculum?**

Pre 1994	1994 Syllabus Revision Process	Curriculum 2005 And the Review	National Curriculum Statement
1	2	3	4

2. **What was your role in the process?**

Chair of the Working group	Member of the Working group	Member of a reference group	Consultant/Advisor	Mentor
1	2	3	4	5

3. **Why do you think you were chosen to be part of the process?**

5. Why do you think there was a need to review/ reform the Natural Science curriculum at the time that you were involved?

6. Which organisations/ interest groups were represented in:

6.1 the task team /committee

6.2 support/reference group

7. How strongly would you rate each of the following statements about the policy making process?

	Always True	Often True	Only Sometimes True	Not True	Definitely Not True
1.Representation was based on expertise more than affiliations with particular groups	1	2	3	4	5
2. The process of consultation was democratic.	1	2	3	4	5
3. Collectively we had rich resources, information and skills to formulate the	1	2	3	4	5

policy.					
3. Some members of the team dominated the discussion and strongly influenced what was put into the final policy.	1	2	3	4	5
4. Much of the discussion revolved around implementation issues and what needs to be done to lay the foundation for implementation.	1	2	3	4	5
5. I felt that I was not able to contribute significantly to the process of policy formulation.	1	2	3	4	5
6. There was extensive discussion around scientific knowledge and curriculum content.	1	2	3	4	5
7. Some members of the team had vested interest in channelling the discussion around certain values.	1	2	3	4	5
8. The task team/ committee operated within an agreed framework of:					
8.1 purposes/goals	1	2	3	4	5
8.2 learning theories	1	2	3	4	5
8.3 content	1	2	3	4	5
9. The knowledge in the science curriculum reflected the interests of academics in the committee.	1	2	3	4	5
10. The allocation of tasks was as a result of collective decision- making.	1	2	3	4	5
11. Compromises of competing interests and demands reduced the integrity of the final document	1	2	3	4	5

PART C

[redacted]

How strongly do you feel about each of the following statements?

PLEASE PLACE A CROSS (X) IN THE APPROPRIATE BLOCK.

	Strongly agree	agree	not sure	disagree	strongly disagree
1. The policy document is easy to understand.	1	2	3	4	5
2. The policy document provides clear guidelines for implementation.	1	2	3	4	5
3. The policy when formulated has/ had					

relevance to:					
3.1 rural pupils	1	2	3	4	5
3.2 urban pupils	1	2	3	4	5
3.3 all pupils (rural and urban)	1	2	3	4	5
4. The policy has been influenced by international trends in science education.	1	2	3	4	5
5. The policy has been influenced by the politics of transition in South Africa.	1	2	3	4	5
6. The science curriculum is intended to develop scientific literacy for all pupils	1	2	3	4	5
7. The guidelines offered in the policy clearly indicate the classroom activities that will result in positive pupil achievement.	1	2	3	4	5
8. When drafting the policy we were aware of the varying contexts of					
8.1 schools.	1	2	3	4	5
8.2 science classrooms	1	2	3	4	5
8.3 teachers' knowledge and skills					
8.4 school management					
9. Schools have the basic level of resources to implement the policy.	1	2	3	4	5
10. The motivation for introducing this policy has been well understood by:					
10.1 science educators	1	2	3	4	5
10.2 parents	1	2	3	4	5
10.3 department officials at provincial level	1	2	3	4	5
10.4 school managers					
11. The policy looked at the historical context of South Africa and embodies principles of enlightenment and liberation.	1	2	3	4	5
13. The policy is flexible enough for teachers to explore the					
13.1 power of science in explanation and development	1	2	3	4	5
13.2 limitations of science	1	2	3	4	5
14. The policy provides opportunities for integration across learning areas/ subjects.	1	2	3	4	5
15. The content and examples offered in the curriculum privilege European and urban experiences.	1	2	3	4	5
18. Common sense knowledge and experience of local culture have been provided for in the policy.	1	2	3	4	5

PART D

Part D intends to gather information on your personal views for the Science curriculum.

1. **What kind of science learner do you envisage as a result of an effective policy?**

____
____
____
____
____
____
____
____

2. **What kinds of *knowledge, skills and values* do you think should be emphasised for a science learner in the GET phase?**

________Knowledge:____
____
____
____
____
____
____
____
____
____

________Skills____
____
____
____
____
____
____
____
____
____

________Values:____
____
____
____

3. What is your own position in resolving the tensions between:

3.1 "Science for all" versus "Science for an elite"

3.2 The same curriculum and content for everyone versus local variations to suit local students

3.3 Science for economic development versus science for personal/social development

PART E

[redacted]

1. **In the science policy document in which you were involved, what do you see as the exciting aspects of content and they ways in which it has been included?**

2. In the science policy document in which you were involved, what do you see as the significant weaknesses in the ways in which content has been defined and included?

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE