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TITLE

How and what are children learning in primary school science?

A study with special reference to three primary science classes

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By

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Declaration

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation, from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature | Signed by candidate | Date: 2 February 2004

Abbreviations

C2005	Curriculum 2005
INSET	In-service educational training
NGO	Non Governmental Organisation
OBE	Outcomes Based Education
NDOE or DOE	National Department of Education
WCED	Western Cape Department of Education
PRESET	Pre-service training
SAILI	South African Industrial Leadership Initiative
PSP	Western Cape Primary Science Programme
GETINSET	The GETINSET project
NGEO	Non Governmental Educational Organisation
RNCS	Revised National Curriculum Statement
SAQA	South African Qualifications Authority
NQF	National Qualifications Framework
UCT	University of Cape Town

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HOW AND WHAT ARE CHILDREN LEARNING IN PRIMARY SCHOOL SCIENCE?

A study with special reference to three primary science classes.

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This research project arose out of my concern that primary school learners do not score well on standardised science tests even when they are taught in apparently functional primary science classrooms. This led me to wonder whether they are learning any generalisable science concepts that they can apply in standardised tests.

I decided to investigate *how* science is taught and *what* science knowledge is developed in three primary science classrooms in different areas of the Cape Flats. As a broad framework, I used the social theory of Basil Bernstein and his concepts of classification and framing to explicate the *how* and the *what* of science teaching and learning.

I observed the classroom activity of teachers and learners. Classroom activity can be viewed as how things are done as well as what is privileged and what is allowed to go on in classrooms. Classroom activity gives rise to inscriptions. In this study inscriptions were taken to mean the observable writings actions and sayings that materialise during or as a result of classroom discourse. I used these verbal, actional and written inscriptions as evidence of teaching and learning.

I developed an external language of description as a tool to analyse the empirical evidence in terms of Bernstein's theory. This external language of description was realised as a set of indicators relating to a four-point scale indicating the strength of classification and framing. The resultant analysis provided a description of the practice that included a measure of the strength of the *how* and the *what*.

The findings show, in terms of the *how*, that these classrooms are well organised and that much of the activity in the classroom makes use of and develops the process skills of science. However, in terms of the *what*, the findings also show that these classrooms are not strong on developing understanding of generalisable science concepts.

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Chapter 1: Introduction

The origin of the problem that led to this research project

1.1. Introduction

This research project is concerned with what happens in science classrooms. To understand its origins it is necessary to look inside the classroom. What follows is a description of a particular lesson in a grade 7 science class on the Cape Flats. The second description is of a learner's realisation of science teaching and learning in the context of an ex-model C school.

1.1.1. A science lesson in a grade 7 class

The learners sat in desks arranged in groups in a class of approximately 40 learners. The teacher began by reminding the learners about the nine planets and the sun, which is the centre of the solar system. He asked one learner to stand in front of the class and represent the sun. He gave this learner a cardboard label reading 'sun' to hold. Then he asked the learners to name the planets. Hands went up. Each time the teacher selected a learner who had named a planet, he handed the learner a label showing the name of a planet. The learner had to go and stand next to the sun in the correct orbital order from the sun. Eventually all nine planets stood in a row in the correct sequence. Then the teacher took out a typed page of questions and read out the first question, 'Which is the hottest planet?' He called for answers. The first answer offered was 'Mars'.

Then the whole class proceeded to move outside where the learners representing the planets and the sun did the 'dance of the solar system' by rotating and revolving around the stationary sun in their orbits. The rest of the class watched. On returning to the classroom the teacher handed out a drawing of the solar system and an envelope containing a set of typed labels each with the name of a planet. Each group had to place the labels on the correct planet in the drawing. The teacher walked round the class and checked that the labels were placed correctly. When he was satisfied, he asked the learners to hand back the drawings and then pack the labels *back into the envelopes and hand those in as well. That marked the end of the lesson.*

On reflection, questions can be raised about the pedagogy in this lesson. Clearly the teacher had prepared for this lesson and the teacher had some teaching strategies at his disposal. The teacher had mastered aspects of classroom management. But *what* science was learned in this 50-minute lesson? Did the amount and quality of science learned justify the time and resources spent? How much science did *each individual* learn from this experience? What would constitute evidence for learning in this case? Did learners show evidence of internalisation and realisation? Clearly one learner at least could not infer that Mercury might be the hottest planet since it is the closest one to the sun. In fact Venus is hotter because it has an atmosphere, but the learners could not have deduced that from the activity.

<u>1.1.2. Experiences of a grade 7 learner</u>

Whilst paging through a learner's science notebook, I stopped at a page headed 'Photosynthesis'. On the page was a set of typed notes explaining the process of photosynthesis. It included a few diagrams showing water moving up the stem into the leaves and arrows showing carbon dioxide and oxygen entering and exiting the leaves. It also had three blank spaces in the text where the learner had correctly written the words 'photosynthesis', 'starch', and 'sunlight energy'. On the facing page was a task sheet about the starch test. The learner had drawn a diagram of the apparatus used in the starch test in the space provided and in another space he had written a number of sentences correctly explaining the method used to do the starch test. When the learner was asked to explain why the starch test is significant when studying photosynthesis, he was unable to articulate a connection between the two. He also told me that the teacher had read through the notes with them in class. The learners had filled in the missing words and then the teacher demonstrated the starch test. Then the learners produced a drawing and wrote up the method on the worksheet.

Some questions were raised about this instance of teaching and learning. It was evident that the teacher had prepared for the lesson. He had collected information about photosynthesis and presented it clearly in written form (although this may have been copied from a text book). Clearly the teacher could perform a starch test and evaluate learners' work describing the method of the starch test. (The worksheet on the starch test was photocopied from education department training documents). But did the teacher himself understand the significance of the starch test to the study of photosynthesis? Was he able to explain this convincingly to learners? How was it that the learner could fill in missing words correctly, understand and write the method for the starch test but at the same time not understand its significance to the study of photosynthesis? How much science teaching and learning was taking place in these lessons? There are similar questions about science teaching and learning which are the subject of ongoing research. One such research project is seeking to cast more light on the classroom practices and their effect on learning, (Malcolm et al, 2002).

1.2. Context of the study

The descriptions above highlight aspects of primary science practice frequently seen by trainers for the Primary Science Programme (PSP). The PSP is a non-governmental educational organization (NGEO), founded in 1983 in response to the critical shortcomings highlighted by primary school teachers as a result of the effects of apartheid policies and practices in education. Its main aim is to train teachers already in service, as well as to develop, resource and support primary science education in historically disadvantaged schools.

In 2001 a three-year longitudinal evaluation of this programme was started. The evaluation aims to:

"describe the PSP and its activities, and explore its impact (a) on curriculum and teaching in the participating schools and (b) on students in classes in grade 5 taught by a teacher who has had some training with the PSP. (Malcolm et al, 2002, p 33)

Malcolm undertook the pilot study in twenty schools, in which the PSP had operated. In this pilot the researchers conducted teacher and student interviews, classroom observation, and tested the learners' performance on standardized tests of the complex task variety [1].

The results of the pilot study showed that teachers generally scored highly on classroom management, and power sharing within the classroom. They scored less highly on connecting science learning to other dimensions of students' experience (especially other cultural knowledges). They also scored less highly on the intellectual quality of classroom engagement. This included higher-order thinking skills and opportunities to explore the problematic aspects of scientific definitions and ways of thinking. (Malcolm et al, 2002, p33)

However, the teachers' perceptions were that their students were more deeply engaged in their learning and enjoyed their classes. Moreover teachers considered that their learners were able to achieve in individual ways. Malcolm et al (2002) reported that these perceptions were supported by the classroom observations and interviews with students.

On the tests developed as part of the evaluation, the students did poorly. This raised questions about the validity of the tests and the interpretation of the data. Language was an important factor, since in almost all cases the students had difficulty using English (an additional language) to read the questions and to write answers. The researchers allowed learners to write in their own language but this did not substantially alter the results (Malcolm et al, 2002, p33).

'When classroom observations and interviews with teachers and students show that classes are well planned and managed, that students are deeply engaged, enjoy their science and feel that they are learning,

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[1] A test item of a complex task variety is one in which the test item sketches a fictitious context and then asks questions which refer to this context but which the learner has to answer using knowledge that has been gained in a different context. In order to show acceptable competence in completing such a test item the learner has to be competent in a complex of areas. Firstly the learner has to be able to read with comprehension in the language of the question. Next the learner has to interpret the fictitious context correctly. Then the learner has to decide what knowledge and skills are needed to complete the task and then has to apply them correctly to the fictitious context in the question. So the learner has to show competence in interpretation, in knowledge recall, in knowledge application as well as in knowledge of and application of the appropriate skills, the application of the appropriate writing skills and genres required to complete the task.

we have to ask ourselves as researchers "What do the students actually know and why?'" (Malcolm et al, 2002, p33).

Malcolm et al (2002) maintained that the tests have shown what the learners don't know. They expressed the need to revise the assessment strategy, and to couple it with in-depth studies of learning within these classrooms.

1.3. Aims of my study

In response to the latter part of the above question posed by Malcolm and Kowlas' pilot study, the aim of my study is:

1. To study the inscriptions that are produced in the pedagogic practice in three primary science classrooms.
2. To understand *how* content is transmitted and *what* is selected . In other words we are studying what is to be selected as legitimate text for transmission.
3. To know *how* the learner communicates content and *what* is selected. In other words we are studying what is to be realised as legitimate text by the learners.

<u>1.3.1. Research questions</u>

- What are the inscriptions (actional, verbal and written) that are produced during science activity in three primary school classrooms? What do they tell us about teaching and learning in these classrooms?
- What can we infer from the nature of the inscriptions produced about the *how* and *the what* of science teaching and learning?

<u>1.3.2. Hypothesis</u>

If learners appear to be deeply engaged in science activity in well functioning classrooms yet fail on standardised tests then it is possible that the recognition and realisation[1] rules of science are not adequately transmitted in the pedagogy.

[1] The recognition and realisation rules are found in Bernstein (1996). The recognition rules provide a way of describing whether the learner is able to recognise the contents and texts in the classroom context. The

1.3.3. Assumptions

It is assumed that C2005 has influenced pedagogy and may or may not be implicated in the poor results shown in the evaluation. It is also assumed that intellectual ability in the majority of learners is not impaired with respect to their ability to learn and master competencies (except in a small minority of cases where clinical learning disabilities have been diagnosed). It is also assumed that much of what goes on in classrooms is not at all obvious unless the minutiae of classroom events are studied.

1.3.4. Research approach

My study set out to investigate the pedagogy in order to find out if there were factors in the pedagogy that may explain the learners' poor results on standardized tests. Pedagogy in this study was viewed as classroom activity which materialised as inscriptions. In other words, pedagogy revolved around what the teacher and learners said, did and wrote in the classroom and the meanings that were made.

Therefore, in my study, it was necessary to analyse what teachers and learners said, did, and wrote. The sayings, actions and pieces of writing were the verbal utterances, the gestures or actions, and the writings (or symbols such as mathematical symbols or artefacts) that carried meaning in those contexts. Kress et al (2001, pg 15) conceptualise meaning-making systems, that is, visual, actional or gestural and linguistic, as modes of communication. They maintain that together these modes provide different potentials for meaning making.

In my study three modes of communication, verbal, actional and written modes. were also conceptualised. Each were also taken as having a different potential for meaning making. However, they differed slightly from those conceptualised by Kress et al (2002). In my study the written category includes visual and symbolic forms, such as posters and

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realisation rules provide a way of describing whether the learner can both recognise the required texts as well a reproduce them in the classroom context. Whilst the possibility exists that realisation and recognition of many kinds of different contents takes place in the classroom, the question here is whether there is recognition and realisation of science contents.

paintings, whereas Kress et al (2001) would include posters and paintings in their visual category and not in their written category. In my study the sorting collecting and making of artefacts are seen as actional, in which the learners have to employ bodily actions in order to achieve the productions, whereas Kress at al (2001) would include the finished artefacts as part of their visual mode.

In my study, each of the three modes of communication were further categorised into individual inscriptions which arose from different motivations, and carried different contents, were used with different intentions, interacted with other modes and resulted in different effects. Each mode, in effect, became broken down into inscriptions that had functionally specialized meanings. For example when a teacher or learner was using speech (producing a verbal inscription) he or she was doing so to convey a meaning, for example, a particular instruction, or an explanation, or reporting a procedure, and so on, in a particular context. Similarly when carrying out certain actions or writing, different actional or gestural and written inscriptions would arise. These individual inscriptions have a particular intention or motivation and content and, in turn, would produce different effects and responses in the listener or receiver.

In my study these inscriptions can be regarded as the units of communication, which were the material productions of the rhetorical processes that took place during classroom interactions of any kind.

' The process of organizing these modes into a communicative event involves consideration of what is to be communicated, and how this can best be done given the functional specialisms of each mode available within the science classroom, the interests of the communicator, and her or his (constantly adjusting) sense of the audience' Kress, Jewett, Ogborne and Tsatsarelis, (2001, pg 17.)

Furthermore, for the purposes of this research, the inscriptions carrying their meanings were taken as evidence of the teaching and learning process (pedagogic discourse). It was therefore possible to make inferences about the nature of the pedagogic discourse from the inscriptions and their meanings.

This research project is limited to the description of classroom structure, delivery and acquisition, in which, 'the form of the social relation acts selectively on the meanings to be verbalised, which in turn affects the syntactic and lexical choices.' (Bernstein, 1996, p183) It does not deal with the developmental, psychological and affective aspects of pedagogy.

1.4. Summary

This research project therefore will seek to record and analyse the inscriptions (the units of communication) in the pedagogic discourse in order to describe the pedagogy in three primary science classrooms. It will also seek to ascertain whether the nature of the pedagogy can account for the apparent lack of science competence in learners.

Chapter 2: Literature review

Following on from my introductory statement, which brings to light questions about the relation between scientific knowledge and science classroom activity as a series of actions and statements, we can see that the actions and statements do not necessarily produce scientific knowledge. That much is clear from my introductory examples. However the problem is that even though we cannot unambiguously trust what has been produced, the actions and statements still remains the only evidence of scientific activity in the classroom.

So the problem for the researcher is one of developing a productive approach to read the material signs of science produced in the classroom. At the most general level it is clear that, minimally, any discursive production, of which science is one example, must consist of recognizable contents and rules for relating those contents to one another.

The purpose of this literature survey is to distil, from the work of antecedent researchers, insights into the relation between the *how* and the *what* of school science. However, in order to structure my discussion in a theoretically principled manner, I shall include a discussion of aspects of the work of Basil Bernstein. While Bernstein's work is not directly focused on science and school science, it is one of the most principled readings of the relation between the *how* and the *what* pertaining to discursive production. The *what* and the *how* of the classroom discourse is materially realised in the form of what we will call inscriptions. These include what students and teachers do (actional inscriptions), say (verbal inscriptions) and write or draw (written inscriptions) in the science classroom.

2.1 Social aspects of teaching and learning

2.1.1 A broad framework for describing the how and the what.

In Bernstein's (1996) terms knowledge has to be transformed into pedagogic communication in order to make it available for transmission by the teacher and acquisition by the learner. Bernstein's term for this transformed knowledge is *pedagogic discourse.* In other words the *what* and the *how* of scientific knowledge is transformed into a selection of scientific contents, ways of relating those contents as well as rules for recognising legitimate renderings of those contents. With respect to the acquisition of science, students need to know *what* to produce and *how* to do so, that is, they need to be able to *recognise* the appropriate contents as well as *realise* the appropriate renderings of those contents. This means that a child must acquire the *recognition rules*. This is a principle that determines that he/she must be able to *recognise* the appropriate context in the classroom. Further, the child must acquire the *realisation rules,* a principle that contains two dimensions, the *selection* of those meanings and the *production* of those meanings. Furthermore the child must have the appropriate aspirations, motivations, values and attitudes (*socio-affective dispositions*) to become successful in the classroom.

Bernstein (1996) explains that some learners are able to recognise the context but are unable to produce the required text. In this case they are said to have *passive realisation*. But if they can both recognise the context and produce the required text they are said to have *full realization.* According to Bernstein (1996) the relation between these principles (recognition and realisation) is such that the recognition rules regulate the realisation rules. Both principles are socially acquired and so are the socio-affective dispositions. They become part of the student's internal structure.

With reference to my project and the examples discussed in the introduction, we can see that there is the possibility of a particular pedagogic context producing recognition and realisation rules that fail at a more general level. In other words when children are assessed in a more general context (national or standardised testing), even though they perform adequately in class, they are found wanting. In the light of this complex situation, this research project seeks to provide an account of the internal workings of the production of school science in classrooms so that we might better see where and how science education succeeds and fails in my sample.

Luria (1976) assumed that the classroom is a microcosm of society. This means that the classroom mirrors the kinds of activity that takes place in society at large. Luria (1976) maintains that the structure of thought depends on the dominant type of activity in society. Therefore social changes *(the how)* are accompanied by fundamental changes in thought processes *(the what).* In South Africa, the political and social changes have brought about changes in the ways we think about education and how it is to be measured and practiced, as seen in the current educational policy documents, such as C2005 (DOE, 1997) and the revised National Curriculum Statement (DOE, 2002).

2.1.2 Social change and its effect on the how and the what of teaching and learning.

Luria (1976) tells us that the higher mental processes, such as those required in order to know *(the what)* and do science *(the how)*, have a social origin and: 'More over, some mental processes cannot develop apart from the appropriate forms of social life' (Luria, 1976, p10). Luria's research took place with unschooled adults who demonstrated changes in their mental processes towards higher mental processes as a result of receiving formal schooling in adulthood. In the context of social changes in post apartheid South Africa changes have consequently occurred in educational policy. This policy requires that in primary school science classes children will have to practice and show competence in the higher order thinking skills, such as in the designing and carrying out of scientific investigations (RNCS, DOE, 2002, Natural Sciences Learning Outcome 1). In other words children will have to think and behave more like scientists do and so the higher mental processes to be developed also apply to children in primary school science classes.

2.2 Curriculum design

2. 2.1 Effects of curriculum design on the how and what of teaching and learning.

Hewson, Beeth and Thorley (1998) are also concerned with *how* children learn science and propose a model of teaching called 'teaching for conceptual change'. In this model learning is seen as conceptual change. It is described as an 'active, interactive, connective process requiring change of different kinds such as addition, linkage, rearrangement and exchange' (Hewson et al, 1998, pg. 1). They developed two concepts with which to describe learning. The first is conceptual ecology and this refers to all the knowledge a person has, whilst status refers to the status that particular bits of knowledge or ideas have for the person using them to interpret his or her world. In this model learning is viewed as a process by which the learner has raised the status of a bit of knowledge within the context of his or her internal conceptual ecology.

However Hewson et al (1998) caution that although we may assume that better models of teaching result in better learning, in reality this relationship plays out on complex ways and is therefore' not simple, not one-to-one, not unique and certainly not causal (e.g., Driver, Asoko, Leach, Mortimer and Scott 1994; Hewson 1991). That being said, Hewson et al, have nevertheless distilled certain principles from research literature, (e.g. Martin and Sugarman, 1993), which serve to support learning as, and teaching for conceptual change. They have further developed these principles into a set of guidelines to inform and support curriculum design and teaching strategies. They point out that is possible to take up these principles within a broad range of teaching models, since there are many different ways of teaching which can succeed in meeting these guidelines. Moreover conceptual change may also happen in classrooms that are not consciously teaching *for* conceptual change, but Hewson et al (1998) contend that conceptual change is likely to happen with more frequency in classrooms where the teaching consciously seeks to meet the guidelines.
The guidelines were stated as follows:

'IDEAS: Both Students 'and Teachers' Ideas Need To Be An Explicit Part Of Classroom Discourse.

METAGOGNITION; The Discourse Of The Classroom Needs To Be Explicitly Metacognitive.

STATUS: The Status Of Ideas Needs To Be Discussed And Negotiated.

JUSTIFICATION: The Justification For Ideas And For Status Decisions Needs To Be An Explicit Component Of The Curriculum. (Hewson et al, 1998, p8-19)

Hewson et al (1998) also point out that in learning, there is emphasis on the individual to take charge of his or her own cognition, within a given social setting and to take responsibility for this or her own commitment to learning. But learning is mediated through social interaction and the teacher's role is crucial within this, so that a suitable social environment is created ' as well as making available to their students scientific standards of evidence, forms of explanation, methods of enquiry and outcomes of investigation' (1998, p5).

2.2.2 Effects of specially designed teaching sequences on the how and the what of teaching and learning.

Leach and Scott (2000) were concerned with the effect on learning of specially designed teaching sequences. They reviewed the work of others, notably Rainson (1999) and Brown and Clement (1991) where gains in learning (the *what*) were attributed to the design and sequencing (the *how*) of specific teaching sequences (made up of models and activities). However Leach and Scott (2000) were concerned that even though a teacher might use a given teaching sequence designed to convey a specific learning goal, the success of that sequence would depend on how the teacher presented and mediated it using language and other semiotic means (in which the students were also players). In other words the teaching sequence cannot be separated from the teacher. They used the term 'staging' to describe mediation by the teacher. The term 'staging' refers to the features of the teaching situation promoted and used by the teacher such as, the sequence in which the ideas were introduced (the *how)*, the use of particular analogies (the *what*), the forms (the *how*) of student practical work, and so on. The teacher's own knowledge was also a factor that influenced the mediation or 'staging' of the teaching and learning process. In this regard Leach and Scott (2000) introduced the term 'conceptual territory' to focus on the teachers' knowledge of the concepts pertinent to the teaching sequence as well as others more loosely connected to it. If the teachers had knowledge of the 'conceptual territory' of the teaching sequence then the teacher was able to pose questions that were able to challenge the students' thinking sufficiently, and were able to respond appropriately to students in terms of the learning goals.

So once again it seems that the *what* of the teaching sequence is influenced by the *how* of the teaching and mediation process, and vice versa. Further, Leach and Scott (2000) made important points about the design and evaluation of teaching sequences as well as the indivisibility of the teaching sequence from the teacher and her mediation. They regarded a teaching sequence as a series of activities that can be used to develop 'conceptual and epistemological themes' (Scott, 1998). However the activities carry no meaning in themselves. 'Rather meanings have to be introduced, rehearsed, and checked on the social plane in such a way that the students and teachers in the classroom develop shared 'common knowledge' (Edwards and Mercer, 1987). In other words students come to the meanings and understandings by being taught, and so the role of the teacher and her mediation skills are central. But how is this done?

Leach and Scott (2000) emphasised that it is only when the activities and the scientific meanings are brought into the social plane in the classroom that the meanings can be explored dialogically (between students and teacher and between students and other students) and thus shared meanings arrived at. Furthermore it is not enough to generate understandings on the social plane alone. The teaching sequences also have to provide opportunities for students to apply and practise those understandings individually so that they are internalised on a personal level. In this regard Brown and Clement (1991) noted an improvement in the success of teaching sequences when there were more opportunities for students to give explanations in oral or written form in order to internalise their understandings. They emphasised the importance of the teacher's mediation in 'talking into existence' (Ogborn et al, 1996) the science narrative that has been designed into a teaching sequence

Malcolm and Keane (2001) used the principles of curriculum design to inform pedagogic discourse and sequencing. They researched the teaching of a sequence of activities on "Learning to work scientifically'. This was an exemplary learning module developed by the Gauteng Institute of Curriculum Development. An important design feature of the module was the idea of 'Curriculum as story.' In other words the metaphor of narrative (the *what)* was incorporated into the design of the curriculum and this influenced the way (the *how)* that teachers staged the module of lessons. They were concerned to measure its success in terms of learning outcomes of the pupils. Although the researchers were confounded to some extent in their attempts to assess satisfactorily the many different kinds of pupil outcomes, they nevertheless report that for many teachers the idea of "'curriculum as story' was liberating and that pupils enjoyed its organic, multi-layered approach and the ways in which different pupils were drawing different meanings from it."(Malcolm et al, 2001,p9)

2.3. Science curriculum contents: the what of the science curriculum

2.3.1 Scientific literacy

Hewson (2002), in debating the design of a curriculum proposes one that would promote scientific literacy. He argues that the tools for scientific literacy are explaining and predicting rather than acquiring a body of knowledge. However ideas, concepts and theories about the natural world are taken as a given in these two processes.

2.3.2. Scientific activity

Wynne Harlen, (1994, pp2-3) in her work in primary school science over many years, has proposed that school science activity should portray science as:

- a human endeavour to understand the physical world
- producing knowledge which is tentative, always subject to challenge by further evidence
- building upon, but not accepting uncritically, previous knowledge and understanding
- using a wide range of methods of enquiry
- a social enterprise whose conclusions are often subject to social acceptability
- constrained by values (Harlen, 1994, pp2-3)

In a similar vein to Hewson et al (1998) in detailing the process skills of science to be developed in primary schools, Harlen describes hypothesising and predicting as two central process skills. She describes hypothesising as:

'a statement put forward to attempt to explain some happening or feature. When hypothesising the suggested explanation need not be correct, but it should be reasonable in terms of the evidence available and possible in terms of scientific concepts or principles.' (1994, p31),

If children are to do this with any success it presupposes that some scientific concepts and principles have been acquired. Equally, she explains that predicting also presupposes previous knowledge of scientific principles and concepts:

'Prediction is a statement about what may happen in the future, or what will be found that has not so far been found, that is based on some hypothesis or previous knowledge.' (1994, p32),

2.3.3. Science as a social language

Leach and Scott (2002) also conceptualised science teaching as a way of introducing the students to a particular form of the social language of science that is, to school science. This process is vitally dependent on the role of the able teacher as the mediator in line with the theories of Vygotsky (1994) and Bruner (1985). Leach and Scott (2002) describe this further:

'Scientific knowledge is not there to be seen in the material world. Rather it exists in the language, practices and semiotic systems used within specific communities to account for aspects of the material world. Learners will not stumble upon the formalisms, theories and practices that form the content of science curricula without being introduced to them through teaching. (Leach and Scott, 2002, p121)

Leach and Scott (2002, pp133-135) provide an outline of the processes involved in developing the social language of science in a teaching sequence:

1. **Staging the scientific story.**

   Here the scientific point of view is put forward in the social plane of the classroom as a narrative or 'science story' (Ogborn et al, 1996). The teacher has to stage it in such a way that it presents an intelligible, plausible and reasonable argument for explaining the material world in a particular way. (Posner, Strike, Hewson and Gertzog, 1982)

2. **Supporting student internalisation**

   Here the teacher has to support the learners to make individual personal sense of the story and in so doing to internalise it. This support takes the form of the teacher questioning and responding to students and providing opportunities, in the form of activities, exercises and discussion.

3. **Handing over responsibility to students**

   Here, as students become more competent, the teacher gradually hands over responsibility to them, at first assisting them and then encouraging them to produce unassisted performances.

Wells (1999) extends our understanding of the 'talking into existence' of the contents of learning. In re-examining the theory of leaning put forward by Vygotsky in terms of present forms of classroom practice, Wells takes a broad view of the range of modes of mediation for teaching and learning. Wells maintains that Vygotsky made clear that the means of semiotic mediation were not limited to speech alone. Vygotsky talks about tools for thinking in terms of:

'various systems for counting; mnemonic techniques; algebraic symbol systems; works of art; writing; schemes, diagrams, maps and mechanical drawings; all sorts of conventional signs; and so on.' (Vygotsky, 1981, p 137)

These modes are also implicated in the forms that assessment can take in the classroom. Wells suggests that we could also add the various modes of artistic expression to this, such as dance, drama and musical performance. Wells maintains that all these modes of expression are both means of communication as well tools for thinking. This supports the notion of the multimodal classroom and the importance of including different modes in the transmission and realization of the classroom discourse. My research project will look at inscriptions, which include these different modes.

2.3.4. Developing deep knowledge

Metz (1998) was concerned with the importance of science knowledge and deep exploration. She analysed the literature relating to studies on young children's ability to carry out scientific enquiry. She was interested in the process *(the how)* and products *(the what)* of children's scientific enquiry. Her results show that in the first 6-7 years of school:

- Children can design and implement experiments *(the how)* and develop more knowledge *(the what)* and improve their enquiry processes
- Domain-specific knowledge *(the what)* has a large impact on the adequacy of children's scientific enquiry *(the how)*
- Deep exploration of a few domains *(the what)* supports children best
- Collaboration *(the how)* can raise the level of the cognitive tasks *(the what)* that children undertake

She indicates that the literature is inadequate in that we need more research into the dynamics of the interaction between domain-specific knowledge and evolving scientific methods. In other words, we need more research into the interaction between the emphasis on subject matter *(the what)* and the emphasis on process (the *how)* in the context of children' s science instruction.

2.4 The what of curriculum support materials

Different types of teaching aids and materials are available to teachers and many rely heavily on materials as a tool for mediation. Ntombela, (1999) studied teaching support materials produced by the Science Education Project. These materials were provided to support teachers in their efforts to transform science classroom practice from 'chalk and talk' to a learner centred practical approach. He examined these materials in terms of the support they provided in enhancing the pupils understanding of the nature of science. He found that most of the materials provided activities at the level of exercises that develop skills (such as measuring and so forth) and at the level of experiences where pupils would engage with phenomena. However there were very few instances in the materials that suggested ways to involve pupils in scientific ways of working such as investigations and problem solving. The materials used in the classrooms in which I will undertake my research may have an influence on what children learn.

2.5 How and what children learn

Vygotsky (1978) emphasized the importance of mediation in the teaching and learning situation. Furthermore he tells us that scientific concepts are acquired through mediation or instruction. This instruction includes *how* the mediation is done and *what* the contents are. Internalisation by the learner takes place in the Zone of Proximal Development in which the learner is challenged beyond his or her present mental abilities and is able to achieve competence at a more advanced level with assistance at first, and finally moves from assisted to unassisted competence. (One has to ask whether the grade 7 students described in the introduction to this research project were being stretched beyond their present mental abilities in the lesson about the Solar System? And one has to ask whether the teacher's mediation was successful in the lesson about photosynthesis?)

Working in the child's zone of proximal development points to the crucial role of the teacher in understanding the present competencies *(the what)* (her assessment) of her students' and understanding *how* to challenge them further. This also points to the importance of continuous monitoring and assessment in the classroom and her role as mediator (*what* and *how* she teaches) and the use of other mediators, such as the peer group. *How* and *what* does the teacher mediate in her staging of the lessons so that the learners can eventually achieve unassisted competence in tasks that stretch them?

2.6. The how and the what of assessment for learning

In the science education research literature it is the work of Paul Black (1998b) and his colleagues that focuses on what is most pertinent to my project. Black et al see assessment as formative of student acquisition of what Bernstein would call the *recognition* and *realisation* rules of school science. However Black and Wiliam (1998b) stressed the importance of the 'indivisibility of the instruction and formative assessment practices' (1998b, p8), which confirms Bernstein's point that at the level of classroom practice the whole of the pedagogic discourse is condensed in the evaluative rules of the pedagogic device. Black and Wiliam (1998b) also quote Brousseau (1984) who reminds us that assessment takes place in the social context of the classroom and is carried out by and for 'social actors'; the teachers and students. Black and Wiliam (1998b) also maintained that it is not possible to introduce formative assessment practices (as espoused in the RNCS) without also bringing about a radical change in classroom pedagogy. Therefore it is clear that formative assessment practices, which produce the relevant evidence, can only be generated through appropriate activities and tasks in the teaching and learning process. The relevant evidence is materialized as inscriptions; what learners say, do and write.

2.6.1. Introducing formative assessment into teaching and learning

In Black and Wiliam's study (1998b) of the formative assessment practices of teachers, formative assessment was taken to encompass 'all those activities undertaken by teachers and /or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged' (Black et al., 1998b, p 2). In general terms, in the climate of formative assessment innovations, it is considered that the quality and nature of the interactions between teachers and students and between the students themselves were crucial determinants in the success of such innovations.

Black and Wiliam's study (1998b) involved a worldwide review of research literature on assessment. The review revealed a number of points, which are pertinent to my study, apart from the general ones already mentioned. The major points are as follows:

1. Introducing formative assessment and paying attention to implementing and developing it in classrooms can lead to significant learning gains. However there is conflicting evidence about the benefit of formative assessment practices with particular reference to under-privileged and under-achieving students.

2. Primary school classrooms in particular are in need of further development in formative assessment practices.

3. Johnston et al, (1995, p359), quoted in Black's (1998b) review, say that although we might regard assessment as practiced in schools as a technical problem, it is has social and personal implications.

4. Many tensions exist in schools to do with assessment. Teachers experience conflicts around the dominance of external or systemic testing in relation to their own testing and classroom assessments.

5. Confident teachers are able to use formative assessment more effectively.

6. The pace of change from more traditional forms of testing to formative classroom assessments and the concomitant changes in the pedagogy is slow, as it takes time to change what has been deeply embedded in teachers' pedagogic practice.

2.6.2. Classroom and assessment activity

The work of Dumas-Carre and Larcher (1987), pointed to three different types of classroom and assessment activity. These types of activities were proposed in order to emphasise to procedural aspects of knowledge whilst placing less emphasis the declarative aspects. They described the following tasks:

- Tasks which present an identical problem to one already studied.
- Tasks presented as typical but not identical to the one studied (but which require identification of the appropriate algorithm and its use).
- Tasks presented as a new problem entirely in which the student must use his or her knowledge in a new way.

The researchers recommended that all three kinds of task should be incorporated into learning programmes or teaching sequences but emphasised that this requires the appropriate planning and foresight.

Johnson and Johnson (1990) Rodrigues and Bell (1995), Cosgrove and Schaverein (1996) and Duschl and Gitomer (1997) were concerned with how the classroom discourse can be moved beyond the everyday knowledge towards conceptual learning, and how to help teachers to do this, Similarly Black (1998b) reported that there is a general concern about how to help teachers and, in turn, their students to develop skill at asking higher order questions. The teacher's own history, knowledge of the subject matter, own theory of learning, and beliefs about his/her students capabilities will influence the teacher's ability to develop higher order questioning.

Black and Wiliam (1998a) also emphasised that teachers' beliefs about their pupils' ability, influenced what happened in the classroom. Teachers beliefs seem to occupy the middle ground somewhere between believing that pupils have a fixed IQ and the view that pupils have 'untapped potential' which assumes that ability is a complex of skills that can be taught and learned. The underlying belief of the teacher will influence the way that she stages[1] the lesson, and the nature of inscriptions she uses and expects from pupils. In other words it appeared that the underlying beliefs, held by teachers, about their students'

[1] The notion of staging was discussed in detail earlier on in this chapter

abilities, influences both the *how* and the *what* of the teacher's transmission within the classroom discourse.

2.6.3 Feedback and formative assessment

The quality of feedback in formative assessment was a key feature, as the feedback must inform how the student is to proceed for success and in turn has an effect on the pedagogy. Feedback was taken to mean " actions taken by an external agent to provide information regarding some aspects of one's task performance". (Black (1998) quoting from Kluger and De Nisi (1996)). Various aspects of formative feedback were highlighted. Formative assessment feedback should be carried out in the belief that every student can succeed and the feedback should be specific to the task and focus on the goals of the task rather than on comparisons between different students work. The criteria that inform the assessment and the feedback and the students' goals should be matched to the students' learning trajectories. In other words they should be aligned to expectations for learners at different ages and stages in development. Attention should also be paid to the quality of the feedback in pointing to the achievement of the learning goals. Feedback is thought to have a negative influence when it draws away from the task and focuses attention on personal aspects of the learner and therefore affects self-esteem. Even praise, when it is non-specific and does not refer to the task can have a negative impact on the student.

2.6.4. Difficulties in implementing formative assessment

A poverty of practice exists in formative assessment, which in turn impacts on the students' success. In other words the *how* of the classroom assessment practices influences *what* the learners are able to demonstrate that they know and can do, as well as influencing their motivation (socio affective dispositions). 'For primary teachers particularly, there is a tendency to emphasize quantity and presentation of work and to neglect its quality in relation to learning.'(Black et al, 1998b, p4). This means that teachers are more concerned with *how* things are done than on *what* is produced in terms of the quality of science teaching and learning.

Black et al, (1998 b), Mitchell (1991) and Boaler (1997) conclude that on the whole teachers are interested in establishing order and routine and making sure that students are functioning well, in line with the constraints imposed by the school structure and society at large. They appear to be less concerned with development of student competencies. In other words teachers are more concerned about the *how* of classroom practice and organisation than the *what* of student learning.

2.6.5. Recognising and measuring student achievement

Yet more difficulties arise when teachers have to interpret student productions even when there are indicators and criteria in place. Teachers need training and practice in this aspect of assessment. Further to this point, Black et al. (1998) cite the studies done by Lorsbach et al. (1992) which questioned whether it is possible for students to construct the intended meanings from the tasks they were given (although the tasks were designed to convey particular meanings). Furthermore they found that teachers had difficulty interpreting what meanings the students had made on completion of the tasks. It was considered that the inscriptions or productions were better indicators of task completion and motivation than they were of meaning and understanding. Therefore questions also arose about the validity of teachers' inferences about student understanding as well as questions about how to judge student understanding and how to write criteria or descriptors for this.

In a study conducted by Reynolds et al (1995) described by Black et al (1998b), a group of elementary school teachers generated a set of indicators, which could give clues to the level of students' understanding. These would allow teachers to make broad inferences about student understanding and are different to the criteria and descriptors that focus on aspects of task completion. These included aspects such as changes in demeanour of learners and an ability to focus. The criteria also focus attention to whether learners are also able to extend a concept, make modifications to a pattern, use processes in a different context, use shortcuts and make explanations.

Black and Wiliam (1998a) suggest that self-assessment by pupils is essential to formative assessment and that students need to have an understanding of the following three elements before they can take action to improve their learning:

1. Recognition of the *desired goal.*
2. Evidence about the *present position.*
3. Understanding of a *way to close the gap* between the two.' (Black et al, 1998a, p6).

Effective feedback as well as competent self-assessment would inform all three elements.

Black and Wiliam (1998a) further suggest that opportunities for *'pupils to express their understanding should be designed into any piece of teaching, for this will initiate the interaction through which formative assessment aids learning,' (their emphasis)* 1998a, p7). In other words, the classroom practices and activities have to be planned so that there are sufficient opportunities for students to learn and to show their understanding through tasks that are specifically designed to reveal student understanding (as opposed to simply revealing the procedural aspects of task completion).

Black and Wiliam (1998b) also refer to the problems associated with summative assessments and the unsatisfactory procedure of determining students' abilities using short decontextualised questions under test conditions. This is because student achievement can vary in different contexts and tests are unlikely to tell us about what the student can do under everyday circumstances.

2.7 Social class origins of learners

Although the above body of research reveals the importance of the teaching and learning process and the concomitant formative assessment practices, that research is less sensitive to the impact of social class origins of students in relation to their acquisition of recognition and realisation rules. The substantial body of research focuses on the acquisition of recognition and realisation rules but which take social class into consideration. It is important in our context to acknowledge that social class is a central variable in the determination of student success in school science.

2.7.1 Impact of social class

Within the framework of Bernstein's thesis Janet Holland (1981) investigated differences in orientation to meaning amongst a group of primary school learner's responses to questions that showed a particular orientation to meaning. Orientation to meaning can be described as the selection and organisation of meaning, of what is seen as relevant and taken as the focus of attention in any situation, and the way in which these meanings are organised in practical discourse. The orientation to meaning is class related. If a child is from a working class background the orientation to meaning is often that of a restricted code, that is, a code that encourages participative thinking. This orientation is different to that of the school in which the orientation is towards mastering complex meanings and taxonomic thinking patterns.[2]

The work of Morais and collaborators (1992a; 2002) take up the challenge of attempting to describe a pedagogic modality that might avoid the negative impact of social class, as described by Holland, on the acquisition of school science. This will be explored in detail in the next chapter.

Black et al (1998b) identified a number of aspects for further research amongst which the following have a direct bearing on my research project.

To research:

'the social setting in the classroom, as created by the learning and teaching members and by the constraints of the wider school system as they perceive and evaluate them.' (Black et al, 1998b, p58)

'the precise nature of the various types of assessment evidence revealed by the learners responses' (Black et al, 1998b, p58)

[2] Restricted code refers to linguistic practices which are centred around interpersonal interactions and that are context embedded. Elaborated code refers to linguistic practices, which are heavily centred towards the transmission of formal knowledge and language structures and that tend towards context independent meanings.

2.8 Summary

The literature review reveals that teaching and learning is a complex process. The *what* of curriculum design plays a part but there are many different teaching models (the *how*) that are successful. Conceptual change and development must be a conscious goal of teaching. Student learning incorporates the social dimension as well a personal internalisation. Science learning includes important scientific literacy skills such as predicting, hypothesising and explaining. It also includes an introduction to the social language of science. Different modes of expression are also thought to be tools for thinking. In the classroom, instruction and formative assessment are seen as indivisible. The quality and nature of the interactions between learners and teachers are crucial to the success of formative assessment. In general teachers are more concerned with how things are done than with the quality of what is transmitted and received. Clearly there is a complex of factors that impact on the *how* and the *what* of teaching and learning. My research project will try to describe the nature of the *how* and the *what* in three primary school science classrooms.

Chapter 3: Theoretical framework

3.1 The pedagogic device

This research project explores how teaching and learning takes place in primary school science classes and what is produced and accepted as science in this context. It is within pedagogic practice and its evaluative rules, that the transmission of scientific knowledge (the 'how 'and 'what' of science) takes place, as well the transmission and acquisition of the criteria by which we judge learning. It is a given that in any teaching and learning process recognition and realisation always take place, in the sense that something is always produced. But this study is concerned about what is the nature of this recognition and realisation.

Schooling is part of social activity and the acquisition of culture. Bernstein (1996) introduced the notion of the Pedagogic Device. This provides a framework and the formal language to describe social structure and the transmission and acquisition of culture. The pedagogic device also provides a structure for describing how teaching and learning takes place in the context of the classroom. The pedagogic device provides a set of rules for describing pedagogic discourse. These are the *distributive rules*, the *recontextualising rules* and the *evaluative rules.*

It is axiomatic in Bernstein's (1996) theory that there is no social existence without the operation of power. The power principle is for the distribution of social goods of which knowledge is one element and this is what Bernstein (1996) calls called the distributive rule. The immediate effect of this is that the power asserts a principle on the *what* (what knowledge or other social goods are allowed to be distributed). In order for the distributive rules to be operative we need the means to make it operative, in other words a *how*. The operationalising principle requires that resources be recruited in a particular way. In other words the resources are recontextualised and this is what Bernstein (1996) calls the recontextualising rule. Once the power principle has been operationalised we need to check or evaluate that what has been operationalised is in line with the principle. This is what Bernstein (1996) calls the evaluative rule. This in essence is the structure of the pedagogic device.

Figure 3.1

Diagram to show how Bernstein's structural model is applied to this research project

Complex representing the intended, perceived, implemented and achieved curriculum

Intended	Perceived	Implemented and achieved
A Education policy, White Papers, Curriculum policy Documents, etc	**B** Curriculum plans, theories of learning, textbooks, teachers plans, syllabi, etc.	**C** Classroom instruction, assessment, student production, etc

Distributive rules ⇄ Recontextualising rules ⇄ Evaluative rules

The *distributive rules* regulate the relationships between 'power, social groups, forms of consciousness and practice. Distributive rules specialise forms of knowledge, forms of consciousness and forms of practice to social groups. And they distribute forms of consciousness through distributing different forms of knowledge.'(Bernstein, 1996, p19) These give rise to government policy on education, curriculum, forms of assessment, and so forth.

The *recontextualising rules* regulate the formation of specific pedagogic discourse. These regulate how knowledge is appropriated and recontextualised and therefore transformed into a specific pedagogic discourse. They give rise to textbooks, materials, teaching aids and other pedagogic texts.

The *evaluative rules* regulate pedagogic practice and transmit the criteria for learning. They give rise to different ways of organising classrooms, and to different ways of teaching, learning and assessing.

However the three rules of the pedagogic device are related in a hierarchy. The distributive rules give rise to the recontextualising rules and these in turn give rise to the evaluative rules. In other words, the *how* and the *what* of the pedagogic device are repeated at every level. Therefore we can view the structure of the education system as fractal. A fractal structure means that there is a self-similar pattern at all levels. For example, at the political level where a democratic system of government exists, this produces a particular *how* and *what*. This in turn determines that the principles of democracy apply at the policy and planning level (Department of Education), where a similar *how* and *what* is produced. This in turn means that, democratic principles are implemented at the level of school organization and a similar *how and what* is produced. Again it is self-similar at the level of classroom practice and in turn at the level of group activity amongst the students. The power principle thus affects every level of organisation in the education system.

I will use Bernstein's (1996) theory of the Pedagogic Device to provide a broad framework to structure and describe this research project. I will use the *distributive rules* to discuss some of the policy undertakings that led to the structuring of the present curriculum. I will use the *recontextualising rules* to discuss some of the features of the present curriculum and how it influences both the pedagogic practice and the curriculum support materials, such as textbooks and worksheets used in the classroom. I will use the *evaluative rules*, to look at the pedagogic practices in the classroom. Within the evaluative rules are the *recognition rules* and the *realisation rules,* which allow us to look at whether successful transmission of knowledge takes place. It also allows us see if there is realisation by learners, and what is the nature of this realisation.

3.2 Distributive rules of the pedagogic device

What kind of curriculum policy has been handed down? In 1997 the national Department of Education (DOE) tabled a new curriculum reform document for South Africa in the form of Curriculum 2005 (C2005). The aim of this curriculum would be to 'bridge all, and encompass all. Education and training, content and skills, values and knowledge' (DOE, 2000,p 1). C2005 was subjected to a review process in 2000. This document states that although 'education (or even curriculum) cannot change society...more and better education to a higher level for all is both good in itself and can create the conditions for enhanced social and personal development.'(DOE, 2000, p1)

3.2.1. C2005 and Outcome -based Education

'C2005 was introduced to set aside the philosophical and pedagogical basis of apartheid-education once and for all' (DOE, 2000, p1). C2005 also fell in line with the vision and goals of the National Qualifications Framework (NQF) and The South African Qualifications Authority (SAQA), in that the curriculum was to be a 'systematic framework for organising education and training around the notion of learning outcomes' (DOE, 2000, p1).

Adopting Outcomes as the goal of education in the curriculum grew out of the struggle against apartheid. During this time alternative and informal pathways to learning achievements were provided through the work of churches, NGOs, workplace training and other civil organisations. The goal of SAQA was to provide an integrated national framework to take account of these learning achievements. Spady (1994) and his notion of Outcome-based Education (OBE) also had a major influence on the adoption of an Outcome-based approach to C2005. The official documents link C2005 to national goals and do not distinguish clearly between C2005 and OBE.

The C2005 was seen as a planned process and strategy of curriculum change that would try to bring about redress, access, equity and development, by focusing on learner achievements. The outcomes-based 'spin' on the curriculum has focused 'on the WHAT and WHETHER learners are learning well, as more important than WHEN and HOW they learn it' (DOE 2000, p10). Furthermore it would do so by employing the methodologies of progressive education in order to reach the described outcomes. Added to this is the emphasis from OBE on 'defining, organising, focusing and directing all aspects of a teaching system in relation to what we want ALL learners to demonstrate successfully when they exit the system.' (DOE, Teacher Manual for Grade 7, p11) This resulted in a vision of classroom practice being described as learner centred, with the teacher as a facilitator. The curriculum should contain relevant content, contextualised knowledge and the learners should be active. This learner should be one who thinks for himself, learns from the environment and responds to teachers who value creativity and self-motivated learning (DOE, 2000, p10). In addition content was de-emphasised and there was a blurring of the boundaries between disciplines in the content. These issues of content were further influenced by Spady's (1994) notion of 'Transformational OBE which emphasized learning shaped by outcomes, integrated knowledge and formative assessment' (DOE, 2000, p11).

3.3 Recontextualising rules of the pedagogic device

How have teacher trainers, INSET providers, materials writers and teachers themselves interpreted C2005? In this section I will discuss different aspects of the C2005 design with reference to the recontextualising rules.

3.3.1. The effect of the recontextualising rules on discourse

Any field of knowledge, such as science, gives rise to a discourse peculiar to that field of knowledge. However, when such knowledge is appropriated from a given field such as science for pedagogic purposes, the discourse becomes transformed. This new discourse is called the *pedagogic discourse.* The recontextualising rules of the pedagogic device bring about a new discourse, distinct from the discourses of the field of science. It consists of an instructional discourse embedded in a regulative discourse in which the regulative discourse is the dominant discourse. In this case it means that a science discourse, which originates in the field of science, becomes embedded in a regulative discourse that originates from government policy. The result is that school science can only be taught in a particular way that is determined by the government through its education policy. How does this happen?

Textbook and syllabus writers and curriculum planners, use knowledge that is generated in fields of knowledge and practice, for example, in the fields of chemistry or physics or ecology and so on. But when this knowledge is taken and recontextualised, it undergoes a change into a new discourse. It is now subject to the education policy of the day (provided the policy has been well communicated). A pedagogic discourse has elements of the knowledge field that gave rise to it and elements of design in line with what government has stipulated, but it differs from the original knowledge field in fundamental ways. For example, in the field of science, scientists carry out day-to-day tasks. They use technologies. They make measurements and observations. And they write and publish papers, which have been subjected to a review process and so produce new knowledge that has wide acceptance for a time until further knowledge supersedes it. In classrooms, by contrast, the children measure and make observations. They develop their thinking skills, come to new personal and shared insights and understandings. But classrooms do not generate new generally accepted knowledge in the field of chemistry or physics, nor do children behave exactly like scientists. They may mimic aspects of the ways in which scientists work and they may learn scientific concepts. But they are not scientists qualified in any field of science since they have not built up the huge body of knowledge, concepts and skill which scientists use as a springboard for new scientific research.

Thus the function of pedagogic discourse is to transmit appropriate knowledge, concepts and skills (practical and thinking skills) and social order (the social order stipulated by the state via the curriculum policy). It specialises text, time and space and brings them into a special relationship with each other. The discourse also constructs category relations that have implications for classroom practice and pedagogical ideology (Bernstein, 1996, page 39).

3.3.2.The influence of C2005 on recontextualisation of the discourse

Curriculum 2005 influences the pedagogic discourse through production of curriculum support materials, the de-emphasis of content, integration of content, formative assessment, and thinking skills. These aspects will be discussed in detail below.

3.3.3 Production of Materials

Apart from the teacher as mediator, one of the main ways in which the science curriculum is mediated in the classroom is through materials. Materials were identified as a key issue in successful implementation of the curriculum. C2005 created an expectation that teachers would design their own learning programmes by writing their own materials and/or selecting from available resources (DOE, 2000, p15). This seems at odds with the concept of the teacher who operates at the level of classroom practice and is therefore primarily concerned with the evaluative rules but is now required to become a programme and/or materials developer and must therefore become concerned with the recontextualising rules as well. This represents a major shift in the role of the teacher and the expectations of the expertise they must acquire.

Many teachers, particularly in the primary school, who received little or no training in science and had poor training in developing learning programmes and in writing materials, expressed dismay at this. This is corroborated by the findings of the C2005 review document (DOE, 2000), which stated: "In the majority of contexts, teachers do not have the time, resources and often skill to develop their own materials" (DOE, 2000, p20). There were no training programmes in place for teachers to gain the knowledge and skills needed for this new role. Neither were there examples of learning programmes available as models for teachers. Some INSET providers responded to this by developing example learning programmes which teachers could follow and in time adapt to suit their circumstances. In this way the programmes could evolve into the teacher's own unique learning programme over time. The report of the review document (DOE, 2000) points to the preparation of illustrative learning programmes in 1997 as one of the key moments in the emergence of the C2005.

3.3.4 The de-emphasis of content

A group of interviewees from the DOE (2000) noted that content was de-emphasised and that there were blurred boundaries with respect to the content areas. They reported that ignoring content was problematic, especially considering the fact that teachers' content is weak. (DOE, 2000, p10) This is particularly so in the primary school since teachers are generally not subject specialists. Indeed they were trained as generalists and usually teach across the curriculum. (It seems paradoxical that teachers who must teach all subjects have no specialist training in any of them)

Also, in the search for new language to describe a new curriculum, certain useful terms and methods have been lost. Concurrently there has been a loss of important concepts 'that should have a place in any inclusionary educational curriculum. These include ordinary words such as 'teacher', 'student', 'subject', 'discipline' and 'textbook' (DOE, 2000, p16). The loss of the concept 'discipline', in the sense of specialized area of knowledge such as science or history or geography containing specific concepts, may have led to the content of such disciplines becoming under-emphasised. This has consequences for social and personal development.

However ironically, the *quality* of outcomes is heavily dependent on the inputs. For some, 'the curriculum continues as a narrow expression of social goals to enskill for work alone rather than also creating fully-rounded human beings.' (DOE, 2000, p17)

3.3.5. Integrated content

Under the influence of progressive education philosophies and that of transformational OBE, C2005 emphasised the *integration* of content, both between learning areas and within a learning area. The integrated and non-disciplinary vision of knowledge is conceptualised in three different ways in C2005. Firstly it seeks to establish a closer relation between education and training. Secondly it takes aspects learned from experiments with a curricular initiative called 'integrated studies' implemented in some schools. And finally it tries to promote the integration of school learning with everyday life (DOE, 2000, p11). However the integration of content to some extent has always been a feature of primary school practice particularly where there is across-the-curriculum class teaching.

But strong integration requires thematic continuity and, whilst the outputs of OBE are prescribed in the form of outcomes and standards to be obtained, the inputs mediated by teachers and materials are discretionary and depend on the context of the learners. However themes were prescribed in the form of phase organisers as well as specific themes in the Natural Sciences, which is at odds with the discretionary nature of the inputs in the design of C2005 (DOE, 2000, p31).

Another issue that is problematic is that: 'When learning areas with distinctive conceptual coherence requirements are driven mainly by integration requirements, then the potential for conceptual progression is retarded ' (Free State DOE submission, DOE, 2000, pg 42).

The C2005 curriculum model is strong on integration and weak on conceptual coherence or progression (DOE, 2000, p 44).

3.3.6. Formative assessment

Whilst Spady (1994) emphasized the importance of formative assessment, there appeared to be an emphasis in the curriculum on developing and assessing competency. This is evident in the language of the specific outcomes, which states that the learner must *demonstrate* the outcomes. This means that the content to be assessed must be housed in a suitable form and language of communication. The learner has to be competent not only in the skills and content of the discipline, but the form or genre of communication as well as the language of communication for the purposes of demonstration. This shifts the implementation of the curriculum towards competency–based learning and assessment. But Jansen and Christie (1999) argued that learning is not either content or competency based. It must involve both content and competency acquisition.

3.3.7 Thinking skills

One of the stated aims of C2005 is the development of education and training, content and skills, values and knowledge (1, DOE, 2000, p 1) as quoted earlier. Skills do not only refer to practical skills. In the natural sciences learning area, the practical skills are a small subset of the science process skills. The science process skills refer to the range of thinking skills that the curriculum requires learners to develop and use across all three learning outcomes. (DOE, 2002, Revised Curriculum Statement, p 13-14). In the case of science education, learners employ practical skills and in the process develop the necessary thinking skills to, in time, be able to make logical deductions based on evidence.

'...science education is heavily dependent on educational processes and experiences which stimulate curiosity and foster habits of purposeful enquiry. In this sense, assessable outcomes on what qualifying students can do (their applied competence) are only a fraction of the real outcomes, which have to do with the **why** and **how** they will do things.' (DOE, 2000,p13 quoting from submission by Academy of Science of South Africa).

3.4 Evaluative rules of the pedagogic device

The whole of the pedagogic device becomes condensed in the evaluative rules. Evaluation is the carrier for the distributive and recontextualising rules (Bernstein, 1996, p 50). In other words, once a pedagogic discourse has been constructed it has to be transformed into pedagogic practice. The C2005 review report states that:

'The dominance of outputs over inputs aside, outcomes-based education foregrounds four features prominent in the curriculum reform the world over. These are:

- The active learner and ideas of uniqueness and difference
- The active teacher who, rather than follow a prescriptive syllabus, makes decisions about what to teach and how to teach it
- The relative importance of activity and skills as a basis for knowing and knowledge
- The relative importance of induction over deduction.' (DOE, 2000, p46)

But how do these features of the curriculum become operationalised into classroom practice. We have seen that the recontextualising rules bring about a pedagogic discourse, which consists of an instructional discourse embedded in a regulative discourse. Further operationalisation takes place when text is transformed into specific content to be taught and evaluated. Time is demarcated into periods, or terms, or years, which ultimately constitute age groupings in a school during which certain content is acquired. Space is appropriated and organized in classrooms and outside them too. Desks and bookshelves and cupboards are arranged, children are seated in certain arrangements, and equipment is deployed. Sometimes learners are arranged in groups so that their learning becomes more social, and sometimes they work individually. And so the context for learning is created. Texts and content are presented, worked with and made, taken and deployed in different ways for different purposes and they make up and reflect the content of the discourse. Teachers also organize and appropriate text in the form of verbal, actional and written inscriptions in a certain sequence and time. For example, the teacher may organise the texts and activities in such a way that very little cognitive development takes place. At other times leaps of cognition are made from which cognitive, cultural and social consequences follow. In this way time, space and text are appropriated so that a certain classroom culture emerges. For example, the class may be teacher controlled or the teacher may frequently devolve power to the learners.

Figure 3.2

Diagram to show the relationship of Bernstein's concepts that pertain to teaching and learning in the classroom and which are governed by the evaluative rules

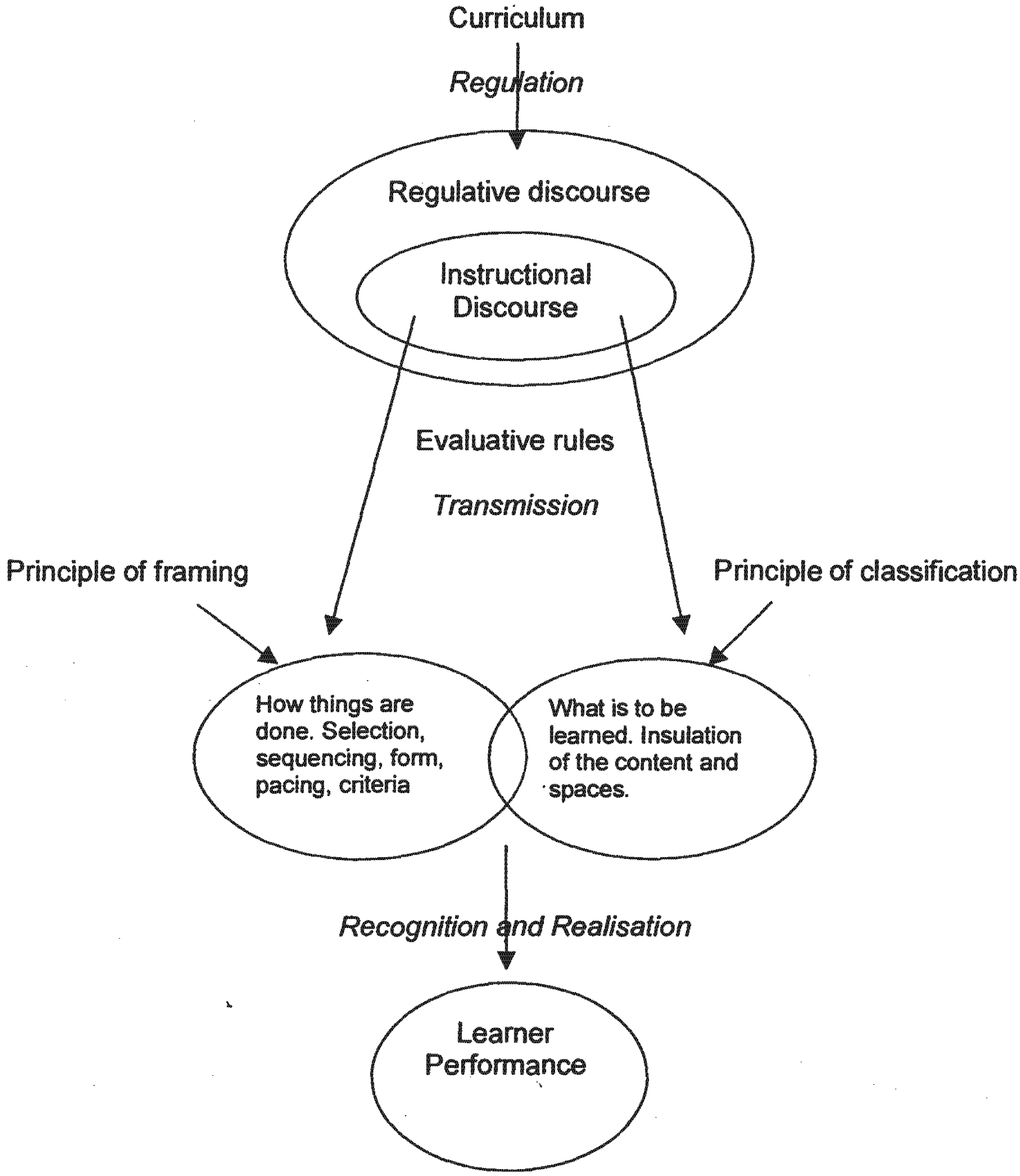


Figure 3.2. shows that at the level of the evaluative rules the instructional discourse is embedded in a regulative discourse. The instructional discourse in turn is influenced by two principles, framing and classification. The principle of framing influences how things are done, whilst the principle of classification determines what is to be transmitted and learned.

Bernstein (1996, p101) introduces the concepts of *Framing* and *Classification* as a further tool for analysing how pedagogic practice or operationalisation takes place. We know from Vygotsky's (1994) theory that learning is both a social process and a cognitive one and therefore involves *social relations*, *content, context* and *individual cognition*. Classification and framing allow us to explain the social relations in terms of the power and control relationships of the classroom. They also allow us to look at the construction of educational content or knowledge by the teacher and the students. Furthermore it allows us to look at individual cognition.

3.4.1 Framing

Framing is used to describe the control relationships that influence 'how' teaching and learning takes place. The principle of framing influences what kinds of activities are allowed to go on in schools. The framing refers to the structuring of the context in which knowledge is transmitted and received. It refers to the specific pedagogical relationship of teacher and taught. Strong framing in the classroom (F+) context indicates that the transmitter (teacher, peer group, text, television etc.) explicitly regulates the selection of content, sequencing, form, pacing and criteria for success that make up the learning context in the classroom. Where framing is strong, the regulative discourse (in which the instructional discourse is embedded), will attempt to attach positive conduct, character and performance labels to learners. Weak framing (F-) allows the learner apparent increased control over one or more elements of the pedagogy. When the framing is weak, the regulative discourse will label learners in terms of their creativity, their participation and their levels of initiative. Framing can be applied to both the regulative context and the instructional context since both make up the pedagogic discourse.

3.4.2. Classification

Classification deals with the power relationships of 'what' is taught and learned in classrooms ' (Bernstein, 1977:88-94; 1996:26-28). The principle of classification influences the content that is taught and learned in school, who decides what the content should be and what form it takes. It is also used to describe and analyse the strength of curriculum insulation. Classification determines whether the content of different disciplines is separated or is integrated across disciplines. It also determines whether there are high levels of specialisation within subjects and disciplines or whether there is integration with everyday knowledge. It also indicates restricted or limited control by the teacher over the content. Strong classification (C+) indicates tight specification over the content and scope of the curriculum and over what is to be learned and when it is to be learned. Weak classification (C-), by contrast, indicates a loosely defined or specified curriculum in which the development of new fields of pedagogical knowledge and new processes of learning are encouraged. This allows an integrated approach to knowledge transmission, where the boundaries between subjects and disciplines are not obvious nor are they clearly defined. Weak classification affords learner more influence over what is to be learned and when it is to be learned. Classification can be applied to both the regulative context and the instructional context since both make up the pedagogic discourse.

3.4.3. Recognition and realisation rules

At the level of classroom events (enactment) classification and framing are a translation of certain rules, which regulate the texts that are used and produced by learners. These rules are the *recognition rules* and the *realisation rules.*

Bernstein (1996, p107) explains that there is a relationship between the principle of classification and the recognition rules for identifying specific contexts. The recognition rules regulate what is recognised by the teacher and learner as legitimate text in that context. A learner is said to have acquired the recognition rules when she can recognise that she is in a science lesson (as opposed to a history class) and therefore must produce the texts related to science content, with its concomitant thought patterns (even if the learner cannot yet produce the full range of responses to this text herself).

Similarly, there is a relationship between the principle of framing and the transmission of the realisation rules. The realisation rules regulate the transmission of appropriate practice, and its concomitant thought patterns, within a discipline. The leaner has to acquire the realisation rule in order to actually produce the legitimate text in the science lesson. In other words the learner has to acquire the necessary knowledge and skills to do this.

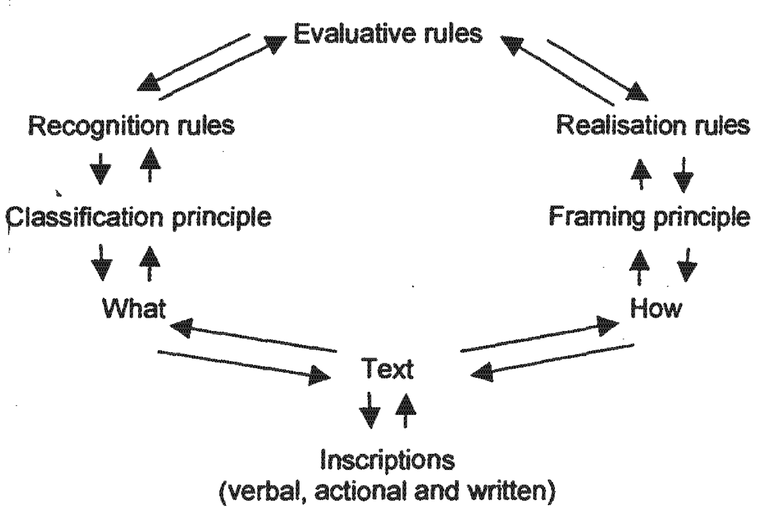
In short: The learner may acquire the recognition rule. This means that the learner knows what content she must include in a particular text if it is to be acceptable. However, in order to actually produce the required text she must know *what* kind of text to produce and *how* to produce it. She must acquire the realisation rule. For example, a child might have to write a report of a science investigation. In order to do this she will need to know:

- The aim, method and results of the investigation and understand which of this information is relevant to her report – recognition rule
- How to write the report. In this case the writing genre may be a sequence of events and written in past tense - realisation rule

The above theory will be related to my research project in the following way. I will use the evaluative rules to research how time, space and text are brought into special relationship with each other in three primary science classes. I will use the concept of framing to interrogate *how* science is to be done and communicated. I will use the concept of classification to interrogate *what* is to be transmitted and acquired by the learners. I will use the recognition and realisation rules to establish whether the pupils have acquired some science knowledge and can show that they have done so in the form of texts. I have subdivided texts further into inscriptions (verbal, actional, and written) for ease of information gathering and analysis. This is summarised below:

Fig. 3.3

Summary of how the evaluative rules apply to the classroom context



Key:
The arrows on the outside of the cycle represent transmission of the evaluative rules
The arrows on the inside of the figure represent acquisition of the evaluative rules

3.4.4 Passive realisation and full realisation

Variations in the framing and classification affect whether the learners acquire the recognition and realisation rules in the preparation of texts. Sometimes a learner may acquire only the recognition rules but not the realisation rules. For example a learner might understand the science content but may not yet have the skills to produce a legitimate text based on this knowledge. When this is the case Bernstein (1996) would say that there is passive realisation on the part of the learner. For full realisation the child will have acquired both the recognition and realisation rules. That is to say, the learner has to acquire both the science knowledge and the skills to produce a legitimate text based on this content.

The recognition and realisation rules of the pedagogic device allow us to look at what learning is taking place. The evidence of learning must be judged by criteria that are derived from the purpose for which the pedagogic discourse was set up in the first place. For example, the purpose of the discourse in the classes to be studied, is to transmit science skills and knowledge and for learners to acquire them. If learning has taken place, as judged by the criteria, then the discourse has successfully transmitted the knowledge and skills, as well as the criteria by which they are judged. There is no pedagogy without evaluation. The evaluative rules hierarchises individuals in that it marks out what is legitimately acceptable and what is not and therefore creates universal hierarchies.

This research project therefore is concerned with:

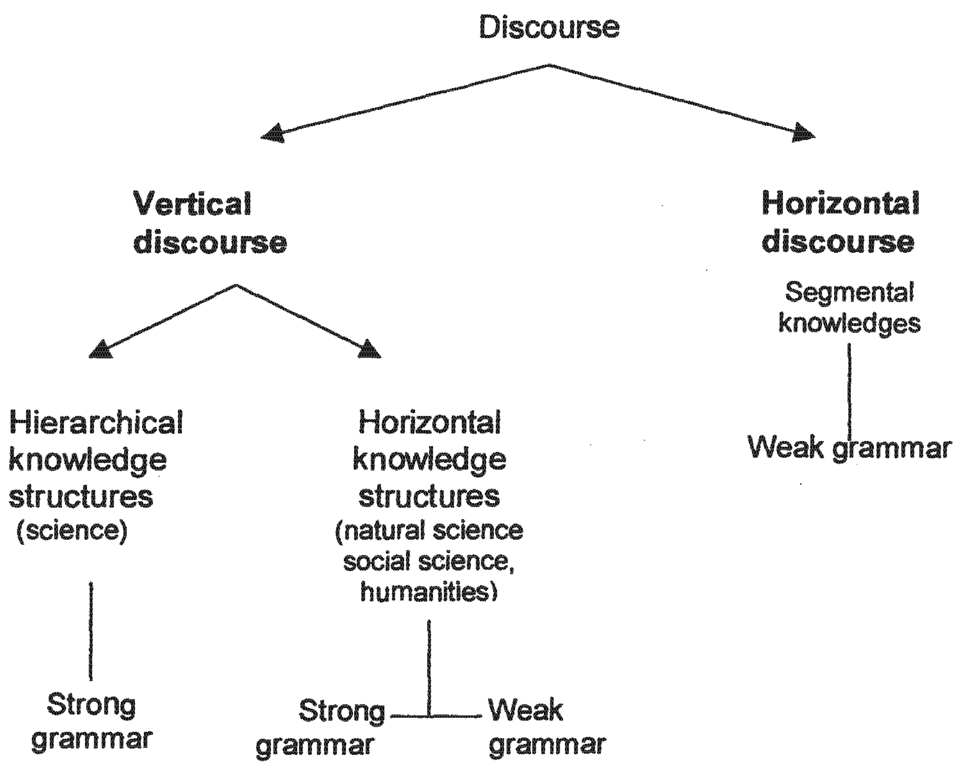
- **How** science is transmitted to learners and **how** they communicate what they know.
- **What** is transmitted to learners as science and **what** science they know.

3.5 Vertical and horizontal discourse

The notions of classification and framing provide a mechanism to describe the structure of classroom practices. From the structuring of the practices we can infer what kind of knowledge structure is privileged in these classrooms. Here it is useful to draw on Bernstein's notions of vertical and horizontal discourses (1999). These concepts help us to further describe how the practices are structured, which in turn allows us to make such inferences.

Firstly, Bernstein distinguishes between two kinds of practice. These he calls Vertical and Horizontal discourses (Bernstein, 1999, pp157-173). Below is a simplified version of Bernstein's diagram, which illustrates the discourses that will be discussed more fully below.

Fig. 3.4. **Horizontal and vertical discourses**



(Bernstein, 1999, p168)

3.5.1. Horizontal discourse

A horizontal discourse is made up of segmentally differentiated knowledges, such as those realised through domestic practices. Horizontal discourse, according to Bernstein, 'entails a set of strategies which are local, segmentally organized, context specific and context dependent, for maximising encounters with persons or habitats' (1999, p159). A horizontal discourse is thus embedded in ongoing practices and is directed towards specific immediate goals that are highly relevant to the acquirer in his or her life.

An example of a horizontal discourse would be the everyday practices that take place in the home. In this case the knowledge structure consists of a set of separate languages used for particular problems. For example, in the domestic situation, a discrete language is used in circulating cookery recipes. This is different from the language with which to circulate information about the safe use of electrical appliances. And this in is different from the language that circulates information about the correct way to brush teeth. Moreover practices and languages differ from culture to culture and within cultures and thus are governed by moral, ethical and socio-cultural unifying practices/ imperatives.

In a horizontal discourse, the language does not lend itself to formulating formal modelling or very accurate descriptions of events or relations between events. This kind of discourse is said to have a weak grammar. In horizontal discourses with weak grammar the discrete languages will contain different names and ways of saying things. In these conditions the learner will need to master the use of the names associated with the language and in some cases the language will come before the event (as in baking a cake) (Bernstein, 1999, p161). Therefore the way that this knowledge or language is transmitted and acquired is through managing the names and the ways of doing things. The segmental organization of the knowledges leads to the acquisition of different knowledges, which are not necessarily connected to each other nor integrated in any way. A horizontal discourse consists of an array of languages. However horizontal discourse of a segmental nature, as described above with reference to domestic practices, differs from the 'institutional pedagogy of vertical discourse' (Bernstein, 1999, p160).

3.5.2 Vertical discourse

A vertical discourse, in contrast to a horizontal discourse, is not a segmental discourse. In a vertical discourse 'the circulation of knowledge is brought about by explicit recontextualisation and evaluation, motivated by strong distributive procedures' (Bernstein, 1999, p159). There are two different kinds of vertical discourse.

3.5.3 Hierarchically organised knowledge systems

The first kind of vertical discourse has a hierarchically organised knowledge system. The field of science is an example of such a system. Science is a vertical discourse, because it is a coherent system of knowledge, consisting of specific concepts, propositions and principles linked by accepted generalising theories and organized in a hierarchical way (Bernstein, 1999, p161). In the case of the sciences this specialised language is said to have a strong grammar (Bernstein, 1999, p 164). In other words the language 'has explicit conceptual syntax capable of 'relatively' precise empirical descriptions and /or of generating formal modelling and theories of empirical relations' Bernstein, (1999, p164). The strong grammar of the hierarchical discourse allows the acquirer to move from one theory to another without a break in the language. For example, a learner learning about the water cycle will acquire understanding of the concepts evaporation, condensation, precipitation and so on. These concepts are linked by theories about the particle nature of matter and the principles of energy exchange. Once learners have acquired this language and understood the principles that govern it, they are free to use this language (these concepts and theories) to explain phenomena in other contexts. For example they are now in a position to explain how washing dries or how fridges work by employing the same concepts of evaporation and so on. This results in an extension of the explanatory or descriptive powers of the language as it moves from one theory to another (Bernstein, 1999, p164).

3.5.4. Horizontally organised knowledge systems

The second kind of vertical discourse is a 'series of specialised languages with specialised modes of interrogation, (and) specialised criteria for the circulation of texts' (Bernstein, 1999, p161). These are said to be horizontally organised knowledge systems within a vertical discourse. (Not to be confused with horizontal discourse and its segmental knowledges). Examples of this kind of vertical discourse would be the natural sciences, humanities and the social sciences. Similarly mathematics is a vertical discourse, with a knowledge system that is horizontally organised, but it has very strong grammar. In other words Mathematics is a vertical discourse since it has strong formal distributive procedures, but is horizontally organised into different strands such as geometry, algebra, arithmetic and so on, but each contains very strong grammar because each has precise concepts which can be employed in developing formal models of real situations.

Teaching and learning in the three primary school science classes of this study, involved a particular kind of social practice in a particular context. Bernstein's (1996) pedagogic device with its concepts of classification and framing and the notions of horizontal and vertical discourse allow us to describe the structuring of this social practice, in this case science classroom activity. The pedagogic device provides the means to describe the operation of power and the relations between people at the social level in the context of the science classroom.

Vertical and horizontal discourses allow us to describe the type of knowledge favoured in the discourse. And whilst it is possible to develop quite delicate descriptors for framing, it is less easy to grasp classification. Classification is intimately related to the operation of the power principle and as we have seen before this is nothing without the operation of the *how*. Observations of classrooms show us how things happen, the pedagogic events, and we have to infer the power principle in operation from these.

However, this research project is concerned with describing the above sociological relations *as well as* how the sociological relations become materialised into texts and what kind of texts are produced. The substantial data of this research project is text (in the form of inscriptions) and it is to the work of Dowling (1998) that we must turn in order to research this aspect. Dowling (1998) has drawn on semiotics and linguistics in order to describe how inscriptions become produced as a result of activity. Dowling's (1998) four domains of practice, which will be described below, provide a conceptual language to further elucidate how classification works at the level of text (and individual inscriptions). In other words Dowling's (1998) work allows us to examine and describe the *what* of the texts and individual inscriptions.

3.6 The four domains of practice

Dowling (1998, p135) introduces the concept of 'domains of practice' to describe how forms of expression and content are specialized by the principle of classification. Any discourse is about a specific specialisation of language, both lexical and grammatical. The form of expression and content of the resulting discourse can each be measured separately in terms of weak or strong classification. These classifications result in four domains of practice, according to Dowling, (p135):

- Esoteric domain – in this domain the form of expression and the content are strongly classified. They are highly specialised and are self referential within the given discipline. For example: explaining how a complex electrical circuit works in terms of the nature of electricity as described by physics and mathematical formulations.
- Descriptive domain – in this domain the form of expression is strongly classified but the content is weakly classified. This results in a practice in which highly specialised forms of expression are introduced in order to explain phenomena relating to content, that falls outside of the specialized subject area. For example the student has acquired the concept of chemical reactions that give off carbon dioxide and uses this to explain how raising agents work in baking.
- Expressive domain – in this domain the form of expression is weakly classified and therefore falls outside the domain of practice but the content is strongly classified and therefore highly specialised. This results in a practice that starts with everyday understandings and forms of expression' and proceeds to more specialised knowledge. For example: describing how water flows in rivers and in our household pipes and using this analogy to contrast the specific nature of electricity flow around a complex electrical circuit.
- Public domain – in this domain the form of expression and the content are weakly classified and therefore not identified with any one specific discipline. For example: making a light bulb light up using any combination of wires and batteries to make an electric circuit which will achieve this result without needing to explain why or how it works. As I have pointed out before, fields of practice with their esoteric knowledge are recontextualised for the classroom. However the non-specialized practice as described with reference to the public domain, is still subject to the regulative

principles of the esoteric domain from which it was recontextualised. The public domain is not external to the practice, although it is unspecialised. However it does contain elements of the fields and activities from which it was contextualised (Dowling, 1998, p136). When public domain knowledge is incorporated into a scientific pedagogic discourse it is subjected to the regulative principles of the esoteric domain of science although its contents are unspecialised.

Fig. 3.5

Domains of practice (Dowling, 1998, p135)

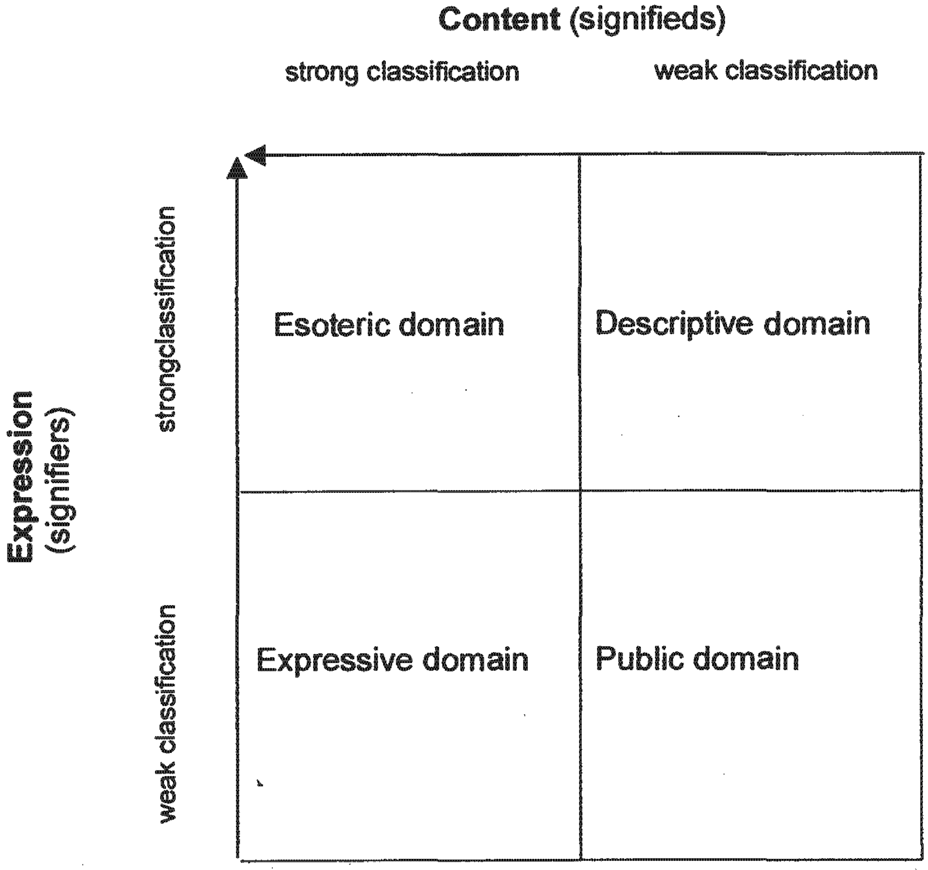


Figure 3.5 shows the four domains of practice and their strengths of classification in relation to content and expression.

All texts and inscriptions consist of a meaning (content) contained in a form or mode of communication (expression) such as a drawing or a piece of writing, and so on. According to Dowling (1998, p135) the articulation of the expression and content (signifiers and signified) is described as producing four primary modalities with respect to strength of classification. These modalities produce four domains of practice: the esoteric, the descriptive, the expressive and public domains. When both expression and content are strongly classified, the domain of practice is described as the esoteric domain. At the other extreme, where both expression and content are weakly classified the domain of practice is described as the public domain. What remains is to describe the situation where one or other of the expression or content is weakly classified while the other is strongly classified. When expression is weakly classified and content strongly classified, we have the expressive domain. On the other hand, when expression is strongly classified and content weakly classified, we are in the presence of the descriptive domain. A few examples may clarify these concepts further. The following passage is an example of the articulation of strongly classified expression with strongly classified content, in other words of the esoteric domain.

Let us consider briefly the structure of a sugar molecule. In one group of simple sugars, the hexoses, each molecule contains six carbon atoms and has the general formula $C_6H_{12}O_6$. (Weier et al, 1982, p63)

Compare this with the following piece of text:

Remember the apple you forgot in your school bag? We all know that food goes bad (begins to rot) if we do not eat it in time. But what causes the food to rot? Talk about your ideas in your group.
(Jones et al, 2001, p24)

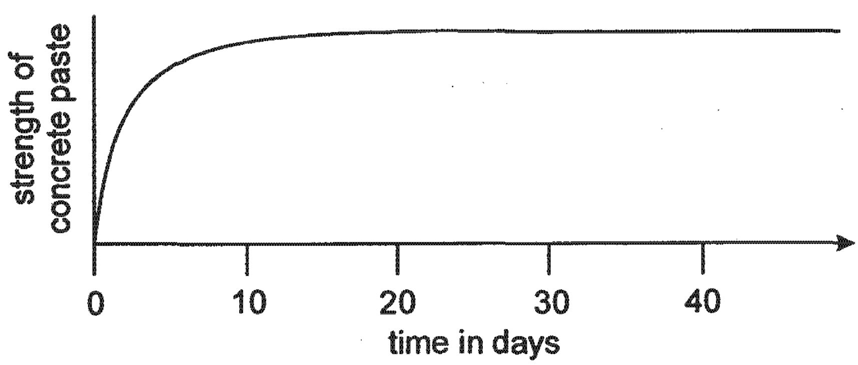
Whereas the example from Weier et al is unambiguously recognizable as science, the above example, although extracted from a science textbook, could conceivably be a task in life skills, science, hygiene, home economics, etc. Note that both the form of expression as well as the content that is to be associated with that expression are weakly classified with respect to science. This is an example of text that populates the public domain. Dowling would regard the production of such text in a science textbook as one of the effects of the scientific gaze on everyday practices.

In comparison to the examples given above, the following piece of text is an example where the form of expression is weakly classified whereas the content is strongly classified with respect to science, and thus falls within the expressive domain.

Large quantities of rock salt are used each winter to keep the roads clear of snow and ice. A solution of salt in water freezes at a much lower temperature than pure water. Wet roads which have been salted will not freeze up unless the temperature falls to 20°C below freezing point-much colder than most frosty nights in Britain. (Pople and Williams, 1980, p41)

In the case of the remaining domain under discussion, being the descriptive domain, the form of expression is strongly classified whilst the content is weakly classified with respect to science. This is commonly recognized as being the 'application ' of science to everyday contexts. The following example serves to illustrate this domain.

Fig 3.6 Graph illustrating a strongly classified form of expression but weakly classified content



(Jones et al ,1999, p56)

In a science classroom, the esoteric domain of science is conceived as having a structuring effect on the discourse. This is even so when the contents originate from practices that are external to science but are recontextualised by it for the science classroom. This recontextualising results in the forms of expression and contents of diverse practices being partially subordinated to the regulatory principles of science.

3.7. Measuring framing and classification

The work of Morais et al. (2001) in Lisbon, in primary science classrooms populated largely by children from working class areas, is included here as it has a direct bearing on my research project. The work of these researchers shows how Bernstein's (1998) thesis of the pedagogic device can be transformed into a language of description in order to understand the pedagogic practice in primary school science classes. Their research project centred on the relationship between teacher's pedagogic practice and children's scientific achievement in primary schools. Previous work by Morais and Neves (2001) had suggested that certain pedagogic practices could overcome the effects of children's social background. Morais and Pires' (2001) study follows on from that study. They were interested in throwing light on the following:

- The sociological characteristics of pedagogic practices leading to the success of all children
- The interaction between learners social background, pedagogic practice and scientific learning
- The distinct characteristics of a pedagogic practice which leads to better scientific learning

For the first two questions they studied the *how* of teaching and learning (the social context of the classroom) and also the *what* of teaching and learning (the scientific knowledge and investigative competences). The *what* of teaching and learning in this case was not focussed on the content of the science theme under study but on the conceptual depth or quality of the teaching and learning. For example, the teacher could implement a pedagogic practice that required a low level of conceptual demand, such as memorization and recall or the teacher could implement a pedagogic practice which had a high conceptual demand, in which learners were required to conceptualise, problem solve and do investigations. The teacher could manipulate these practices in different ways.

3.7.1. Developing a scale for measuring the strength of framing and classification

To study the power and control relations that bring about the interactions in classrooms the researchers used the concepts of framing (control) and classification (power) to characterise the *how* and the *what* of the pedagogic discourse. They studied interactions in both the regulative and instructional dimensions of the pedagogic discourse. They developed a set of instruments (indicators) of pedagogic practice, which had distinct values for framing on a four-point scale. (F++, F+, F-, F--) The scale for framing varied from strong framing (F++) to weak framing (F--). Strong framing characterised teaching and learning which was more teacher-centred whereas weaker framing characterised teaching and learning which was more learner-centred. Framing values were used to characterise matters pertaining to selection, sequence, pacing and evaluation criteria in the classroom discourse.

Scales for classification also ranged across a four-point scale(C++ C+ C- C--) from strong classification (C++) to weak classification (C--). These scales were used to characterise the status of different kinds of knowledges (intra-disciplinary, inter-disciplinary and academic/non-academic knowledges). Strong classification in intra-disciplinary knowledge would mean that there is no integration of content within a discipline. Strong inter-disciplinary classification would mean that a higher status is given to the knowledge of the discipline and there is no integration of content between different disciplines or between school knowledge and learner's own knowledge.

The researchers also applied values for classification and framing to communication between teachers and learners and also between different learners. Strong framing values would characterise forms of communication controlled by the teacher or by specific learners. Weak framing values would characterise forms of communication where there are opportunities for teacher and all learners to interact freely.

Classification values were also applied to aspects of the regulative context, viz. relations between the spaces of teacher-learners and learner-learner and also between learners of different socio-cultural background, gender and achievement. Strong classification would characterise clear boundaries between these spaces.

These researchers used the descriptors with their four point scales as an external language of description in which the theoretical and empirical are viewed dialectically. This means that concepts within Bernstein's internal language of description were used to guide the observation but the empirical data shaped the indicators for framing and classification.

The research method consisted of developing a theoretical profile of pedagogic practice by developing two teaching units which had been characterised for classification and framing values in terms of the pedagogic practice researched in Morais' and Neves' study (2001). In that study the same instruments were used to analyse teachers actual practice when they taught these units. The teacher's actual practice was observed and given a value based on how closely it approximated the values for classification and framing in the theoretical profile of the practice. The values for all the characteristics were added up to give a total score for each teacher. The closer the relation the higher the value given. This was used to explicate the *how* of the practice.

The *what* of the practice (teacher's scientific knowledge) was studied by collecting data obtained from classroom observation and collected in the course of the teacher's training. The teacher's scientific knowledge was considered to have two components: scientific knowledge and investigative competences. Each competence was assessed on a four-point scale where the highest score represented the most competent teachers and vice versa.

The learners' competences were also investigated using tests that contained questions requiring simple and complex cognitive competences. For each set of competences the marks were converted to a three-point scale.

Finally the relationship between the teachers' practice and the learners' competence was arrived at through Variance Analysis followed by a Post Hoc Test when the value for the variance analysis was significant. The relative weighting of each of the characteristics of the children's learning was arrived at using step-wise regression. In the analysis of the children's test data they took the level attained in complex cognitive competences as a measure of achievement. Previous studies (Domingos, 1989 a, b; Morais et al.1992) had shown that differences in competence amongst children of different socio-economic backgrounds is particularly marked when the level of conceptual demand is high.

The results showed that an important condition to the success of children is the scientific competence of the teacher (knowledge and investigative competences), that is, the *what* of the teaching and learning. Furthermore the *how* of teaching and learning is also important. The following characteristics in the pedagogic practice were found to be pivotal:

- Evaluation criteria are made explicit to learners (strong framing of the discursive rule)
- The boundaries between the spaces of the children and the teacher are not rigid (weak classification)
- There is integration of knowledges within a discipline (weak intra-disciplinary classification)
- There is a high level of conceptual demand in the contents
- There is a high level of investigative proficiency

These results supported the earlier findings of Morais et al, 1993; Morais, Neves, et al, 2000; and Neves, 2001 that suggested that a *mixed pedagogic practice* containing the above characteristics could overcome the student's social background even at the level of complex cognitive competences. Morais et al (2001) thus provide a structural description of a classroom practice that indicates conditions for classroom mediation that will overcome student social class differences.

Previously I have stated my concern in the general terms of recognizing the disjuncture between what was taught and learnt in the classroom on one hand and what is required for success on externally motivated assessments of students' knowledge of school science. We can now restate this problem in more technical terms as follows. Teachers and students are confident that science is being taught and learnt because students are able to complete classroom tasks successfully including those supplied by outside agencies. However, when the students are tested with external tests in different contexts they are unable to produce legitimate responses. In other words recognition and realization rules have been acquired in the classroom context, but are apparently specific only to that context. This must mean that the recognition and realization rules acquired in the classroom are clearly not the same as those required for external tests. This is highly problematic since the scientific knowledge is by nature universal and context independent and therefore should be transferable across assessment contexts.

What are the natures of the recognition and realization rules that pertain in these classroom contexts? In the next chapter I will elaborate on the theoretical resources required to begin to answer this question.

Chapter 4: Research Design

4.1. Introduction

This research project takes an eclectic approach for the research design. It uses a qualitative ethnographic approach to describe the classroom practices in three primary science classrooms through the verbal, actional and written inscriptions that are produced by teachers and learners. However it also makes a quantitative analysis to determine the strength of classification and framing of the pedagogic practice. It is important both to describe the classroom culture as well as to understand how strongly that culture is transmitted and received and that is the reason for this eclectic approach.

This research centres on the question of *how* teachers transmit science and *what* is transmitted. It also centres on *how* and *what* science is realised by students in primary school science classes. My research project therefore sets out to:

1. Study the events/ inscriptions that occur in the pedagogic practice in three primary science classrooms.
2. Describe both *what* content the teacher selects and *how* this is to be transmitted. In other words to describe what is selected as legitimate text for transmission.
3. Show *what* content the learner selects and *how* this is communicated. In other words to describe what is to be realised as legitimate text by the learners.

4.2. The research methodology

1. An observation schedule was developed in order to record the inscriptions (actions, sayings and writings) that occurred during classroom activity. These inscriptions were recorded onto a time line and used to construct a description of the classroom activity. This description provided a record of the inscriptions as well as information about the meanings that were communicated. This information was used to construct the indicators for classification and framing in the language of description.
2. A video recording was made of the classroom activity. Its purpose was to verify the observations and record the contents of the inscriptions. Photographs were also

taken for this purpose. These inscriptions were also analysed using the indicators in the language of description.

3. Samples and artefacts, such as learners' writings were collected, and also analysed. These provided information about the written inscriptions.
4. A semi-structured teacher interview was carried out to substantiate the observations and to provide additional information, such as the structuring of the classroom spaces, and this information too was analysed

Data collection methods are looked at in detail in section 4.4

4.3. Population and Sample

The sample was taken from three different primary schools in the Cape Flats area of Cape Town. School A was identified with the help of the GETINSET project. The teacher of Class A had received INSET support in the GETINSET project and was also studying for an advanced certificate in education in science at UCT at the time. School B and C were identified as having functional classrooms and were recommended as likely sites for research by SAILI (South African Industrial and Leadership Initiative) which had provided in-service support in these two schools.

4.3.1. Functional schools and classrooms

The classrooms chosen were regarded as functional. The identified teachers had had training by SAILI or GETINSET and classroom support from these organisations and had been observed in action in their classrooms. This meant that the researcher could be reasonably sure of some productive pedagogy taking place in the classroom on the days when observations were carried out. In addition there were likely to be teaching plans in place, materials and examples of work that could be collected from the teacher and learners.

4.3.2. Competent teachers

The teachers were regarded as competent by the organizations that recommended them. It was decided that it would be more productive to look at what competent teachers do in functional classrooms rather than randomly choosing classrooms, which might only illuminate the functional and organisational shortcomings.

4.3.3. Social background

The learners in these schools came from culturally diverse and mostly working class backgrounds, although a small proportion of learners came from families where the parents are professionals and some learners in school A came from families where both parents were unemployed. The number of families in this situation varies, as employment opportunities change from time to time. In class B there were one or two learners from other parts of Africa as well. The study was interested to see what happens in classrooms that are more representative of the broader population on the Cape Flats, as these schools are, rather than in an ex-model C school or a private school. I was also interested to carry out this research in schools that draw learners from working class areas to ascertain if a mixed pedagogy was found, similar to that described by Morais et al (1992, 1994, 2002) in classes with working class learners.

4.3.4. Medium of instruction

English was the medium of instruction in these classes. It was necessary to make observations where the researcher could understand the interactions taking place. There was very little switching between the languages in the classrooms studied. In addition, although the language of instruction in all three schools was English, a proportion of the learners come from Afrikaans and isiXhosa speaking homes as well. It was of interest to see how the teacher worked with and took account of those learners who are not English speakers.

4.3.5. Different grades

Two different grades were observed for different reasons. In schools A and C a grade 4 class was studied and a grade 6 class in school B. Grade 4 was interesting because it is the first grade in the intermediate phase and it is the first time learners study science in any formal sense. Grade 6 was interesting because the learners are older, have some science already and it is the last year in the intermediate phase. It was of interest to look for any differences between the grade 4 classrooms from different schools and also to find if there were differences between grades 4 and 6. Class A consisted of approximately 56 learners. Class B consisted of approximately 30 learners in lesson 1 and approximately 60 learners in lesson 2. Class C consisted of approximately 30 learners.

4.3.6 Justification of sample selection

Choosing only three classrooms for the sample was justified in terms of the amount of data needed for a dissertation of this length. It was also considered better to study three classrooms in depth rather than many schools in not as much depth. The selection of three 'good' teachers was justified because it was assumed there would be a reasonable amount of content, depth and activity in the classroom discourse as well as a reasonable degree of classroom organisation, all of which would provide data. The context and location of the school was considered before the teacher was approached to take part in the study and the selection of the given schools was justified by the fact that they were located on the Cape Flats, had a culturally mixed population, and occurred in different working class areas which were geographically far from each other, in different education districts. This was justified in that it meant we could compare how 'good' teachers teach and how the students learn across districts but in similar socio-economic settings. We could also compare our findings with those of Morais et al (2001) in similar socio-economic settings.

4. 4. Data collection methods

4.4.1. Development of classroom observation schedule

In the design of the observation schedule the different modes of communication were categorised under the headings: written inscriptions, actional inscriptions and verbal aspects of the classroom activity required learners to discuss given questions or topics. The sub-category called *explanations* gave rise to three primary inscriptions, which refer to different purposes of explanation, namely, explanations of meanings of words, explanations of reasoning and explanations of concepts. The sub-category called *feedback* gave rise to inscriptions in the form of *general or non task-specific feedback*. This would be the case when, for example, a teacher says, 'You have all done well today.' without elaborating or referring to specific aspects of the task. In the category *task specific feedback*, the inscriptions that arose would be about specific contents of the tasks and would be delivered to the whole class or the group or the individual. *Instructions* was taken as a primary inscription in a sub-category of it's own. *Reporting* formed a sub-category, which materialised as inscriptions, which deal with reporting about procedures carried out or alternatively reporting about specific topics or experiences. *Reading aloud* was taken as a sub-category, which materialised as reading aloud for information or reading aloud for story. Similarly, the sub-category of *telling* materialised as telling for information or telling a story.

Each network was transformed into an observation schedule that maintained the relationships of the network but contained space to record the time when each modal A place was also provided where the researcher could record whether the teacher or learner had made the inscription. This information was transferred to a time line for each lesson. *(See appendix I: A1: 5 pp 127-145)*

4.4.2. Classroom observations and video recordings

Classroom observations were made using the observation schedules described above. Classroom observations and video recordings focused on the interactions in whole classes over two consecutive lessons in each class, ranging from 40min to 1 hour per lesson. The video focused on the teacher and sometimes on small groups of learners where something interesting was happening. This was at the discretion of the camera operator, unless the researcher pointed out an interaction to focus on. Extracts analysable by the indicators were transcribed from the sound track

The observation schedule tended to focus on general interactions in the classroom and not on individuals or groups of learners in the class as it was not possible to move around the classroom at the time. A limitation in a work of this length was that exhaustive recording of simultaneous interactions in different groups between individuals was not possible.

4.4.3 Teacher interviews

The interviews were used as a secondary, but complementary tool to validate the information collected in the classroom observations. The interview followed immediately after the second lesson observed. It was conducted in a quiet place away from the classroom. A video recording was made. This was copied onto a sound tape. Extracts were transcribed from the sound track.

The interview was semi-structured and was communicated to the teacher in the style of a review session starting with what was noticed about the two lessons so that the questions did not follow in the same order for each interview. Rather the order of questions was informed by the events noticed in the classroom observation. *(See questionnaire and explanations Appendix 1: A1.6 pp146-147)*

The purpose of the interview was to verify the teachers' intentions and the meaning of the inscriptions. It was also used to gain insight about the teacher's attitudes to learners and learning, her selection and sequencing of content and how flexible her arrangements were in the class.

4.4.4. Collection of samples and artefacts

Samples of lesson plans, learner task cards and examples of learners work were collected. The teachers provided copies of the planned work for the day if available. In one case this took the form of a list of headings of the content the teacher proposed to teach, as well as copies of the instructions/task cards and/or questions they would require the learners to do. In the other cases the teacher simply gave me copies of the task cards and worksheets for the day. These samples and artefacts provided further information for the development of the indicators in the language of description.

The teachers provided copies of learners work relevant to the lessons observed. Each teacher was asked to examples from three highly competent learners, three competent learners and three learners who struggle to complete the tasks.
'Competent' learners, in this case were seen as those who, in the teachers professional judgement, could finish the given tasks to the teacher's satisfaction. The highly competent learners were seen as those whose work and task completion exceeded the teacher's requirements. The learners who were deemed to be struggling, usually could not finish the task to the teacher's satisfaction, although all attempted the tasks and were able to partially fulfil the requirements. The contents of these samples and artefacts were analysed.

4.5. Method of analysis

The primary tool for the analysis is to develop an external language of description.The external language of description is shaped by the empirical observations made in the classroom. The analysis would transform the information into data about *what* the teacher transmits and *how* this is done. The analysis would also provide data about whether learners have acquired the recognition and realisation rules of the discourse. In other words, have learners learned some science, and can they show what they know in the form of some kind of legitimate text. It is necessary to explain what an external language of description means and to explain how it is constructed.

4.5.1. The idea of a language of description

Bernstein (1996,p135) defines a language of description as "a translation device whereby one language is transformed into another." In other words the language of description is a bridge between the language of the theory and the 'language' or 'text' of the observed empirical information. He distinguishes between "internal and external languages of description" (1996,p135). The difference between the two is the following:

4.5.2 Internal language of description

"The internal language of description refers to the syntax whereby a conceptual language is created" (Bernstein, 1996, p135). This refers to the constructs and concepts found in the theory that describes generalisable theoretical ideas (and which also inform the research design).

4.5.3 External language of description

In contrast, "an external language of description refers to the syntax whereby the internal language can describe something other than itself" (Bernstein, 1996, p 136). In other words the theoretical concepts must be contextualised to fit the specifics of an empirical situation whilst in turn, the empirical information is translated into data readable in terms of the theory.

4.5.4. Reasons for an external language of description

The reason for an external language of description is to turn empirical information into data. The construction of an external language of description involves a 'dialogue' between the theoretical constructs and specific empirical information. At the same time the external language of description constructs *what will count* as empirical information that is valid for the theory, and thus in turn, constructs the information as a valid theoretical object. Moreover, the external language of description constructs and defines the specific *relations between* the empirical information and the theoretical concepts in a particular context. But the step of defining the relations between the information and the theory restricts what can count as valid information. (This process is viewed as recognition and realisation of data by the researcher.) Although, a process of selection or restriction occurs as data is recognised and realised, there nevertheless exists a material excess which exceeds what the researcher recognises as data. The fact that the material is always in excess is represented theoretically by the notion of the discursive gap. This is outside of both the internal and external languages of description.

In this research project the internal language of description derives, chiefly, from Bernstein (1996), Black et al (1998a, 1998b, 2000, 2001), Morais et al (1994, 2001, 2002a, 2002b) and Dowling (1993, 1998). A language of description, from this point of view, consists of 'rules for the unambiguous recognition of what is to count as a relevant empirical relation, and rules (realisation rules) for reading the manifest contingent enactments of those empirical relations' (Bernstein, 1996, pp136-7).

At this stage it might help to reproduce a diagrammatic representation of the idea of a language of description from Dowling's discussion of languages of description (Figure 4.1).

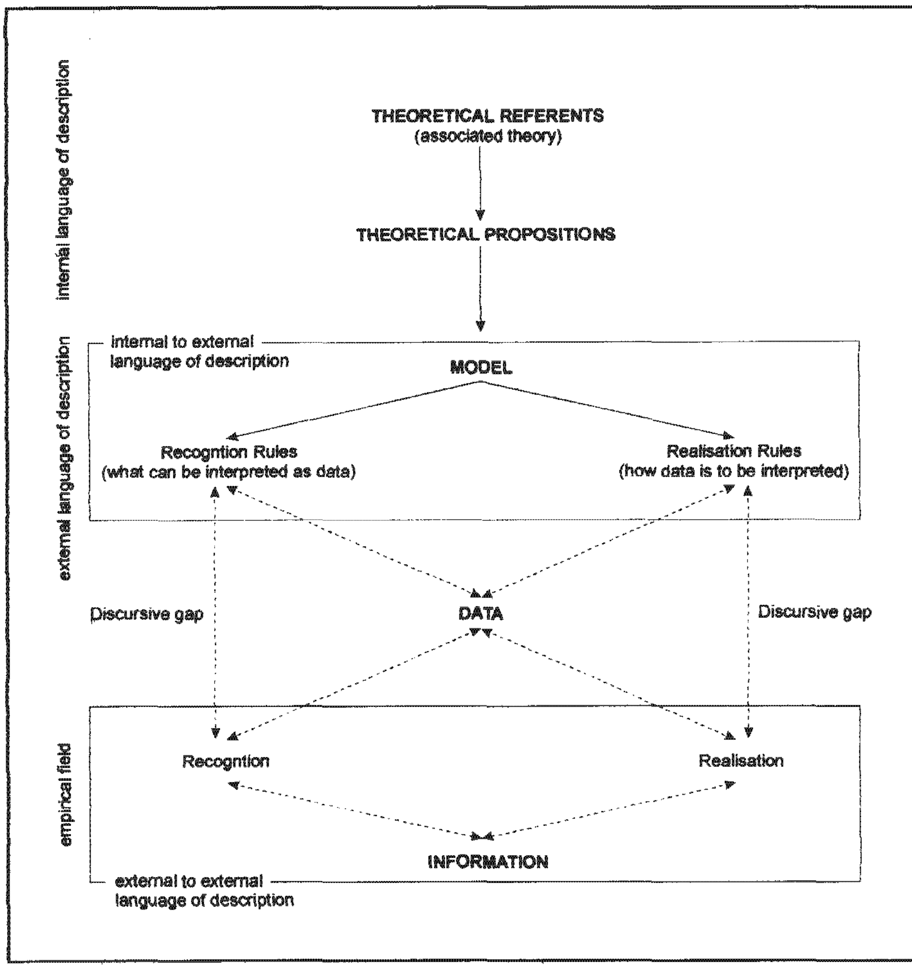


Figure 4.1: Schematic for a language of description (after Dowling (1993: 88))

In my research project a language of description was developed in the form of indicators relating to the strength of the framing and classification on a four-point scale as described in the theoretical framework. These descriptors and indicators constitute an external language of description as described by Morais et al (1994, 2001, 2002a, 2002b).

4.6. Justification for this research project

The reason for undertaking this study was in response to research carried out by Malcolm et al (2002, 2003), which had thrown up questions about poor learner performance. Consequently it was considered valid to examine the pedagogy in science classrooms to find out if there were factors in this pedagogy that could explain why learners might show poor performance on tests.

4.6.1. Justification for choosing a sociological approach

A description of the classrooms in terms of their social structuring was favoured since classrooms are social places. Moreover precedents in the literature Scott (1998, 2001), Black et al (1998a), Morais et al (1994, 2001, 2002a, 2002b), had lead us to believe that the particular social organisation of the teaching setting had effects on the quality of the teaching and learning experience, and on learner realisation. Bernstein's theory of the pedagogic device articulates with the above findings, since it clearly demonstrates that the social ordering of transmission and acquisition is what specialises consciousness differentially. Therefore it was considered that this approach to describing these classrooms was valid.

4.6.2. Justification for analysis in terms of framing (the *how*) and classification (the *what*)

Bernstein's (1996) theory of the pedagogic device was considered the most suitable theory to draw on for this study. The primary reason being that it provided a mechanism for describing the way that the pedagogic discourse was structured, in other words *how* things are done and *what* content was transmitted and received. Furthermore it provided a mechanism for describing the power and control relations that influence the structure of the discourse. This allowed us to look at the influence on the discourse of both the curriculum policy and the teachers' practice. It also allowed us to describe learner realisation as it emerged through pedagogic discourse and to interrogate the *how* and the *what* of the realised inscriptions.

4.6.3. Justification for using Dowling's (1998) domains of practice to reveal the nature of the inscriptions

The language of description based on Bernstein's (1996) classification and framing provided a description of the social structure of the discourse. As such, it was limiting in that it did not provide the means for interrogating the nature of the inscriptions, which materialise in the discourse. But Dowling's (1998) domains of practice provided the means to develop a language of description for this purpose. The four domains of practice formed the basis for an indicator similar to the ones designed for Bernstein's framework, which was capable of providing descriptions related to a two dimensional measure of classification. The method of analysis for this section was to analyse the realised pieces of learners work. The sample was preselected by the teacher, who identified three learners whose work was considered of highly acceptable quality. I then selected the work that was most complete (all or most tasks had been completed and questions answered) or had been awarded the highest marks by the teacher. This was considered a valid way to make the selection since:

- The teacher had selected the texts that she considered showed full realisation by learners. She provided three different sets of examples of full realisation.
- The final selection was based on the teachers awarding of mark scores or her marking which showed the highest degree of correct renderings (As shown by marking ticks next to the work, teachers remarks and teachers signing off of work.)
- In each class all learners were required to submit the same pieces of work, which were mostly in the form of worksheets and pieces of directed writing or drawing. So the types of tasks chosen were representative of the tasks that all learners did in each class.

It was considered that this selection provided a suitable sample of what the teachers regarded as successful realisation by learners. These texts were then analysed using Dowling's four domains of practice.

4.7. Reliability of the research design

The reliability of this research design is established through the following. Firstly, the design of the research method has precedents in the literature, namely, in the work of Morais et al (1994, 2001, 2002a, 2002b). Their research design was specifically formulated to describe a similar context to the present research, that is, primary science classrooms. The external language of description developed by the above mentioned research workers was also found to be generally applicable to the empirical observations in my study although changes and additions were made to create a better fit with my empirical data.

Secondly, the reliability is established through the nature and purpose of the external language of description. The language of description explicitly does not involve the prescription of a model imposed on the empirical. Rather, the model is explicitly shaped by the empirical. It is seen as a dialogue between the theoretical and empirical. Because the language of description does not exist without the empirical it follows that there is always a highly reliable degree of fit between the actual (empirical) observations and the language of description.

4.8 Limitations of this research project

In this research project a sample of only three classrooms was researched, this was considered manageable for a dissertation of this length. However the virtues of a small sample are that we can carry out an exhaustive analysis of teaching and learning in these classes. The types of classrooms selected were limited to those known to be highly functional. This was necessary as part of the research design. The teachers had received significant in-service support and it is acknowledged that this situation is by no means the case in all schools. This project provides a view into the workings of these particular primary science classrooms and as such it is difficult to make any large-scale generalisations from analysis of the data generated.

Two consecutive lessons were observed in each classroom. Each lesson observation lasted between 40 minutes and 60 minutes in duration. Therefore it was not possible to establish whether longer-term teaching and learning outcomes emerged.

In the scope of this project, it was possible to gather exhaustive information about the general interactions at group and class level. But the project was limited in that it was not able to record the inscriptions made by every single learner, particularly in big classes.

4.9. Negotiating access and research ethics

The permission to do this research was sought from the WCED and from the principal of each school in a face-to-face meeting in which the purpose and nature of the research was explained and this was followed up by a letter. *(Appendix 1: A1:1 p123)* The permission of the teacher was obtained in the same way. Before the research observations commenced the researcher explained to the learners what the research was about and obtained their consent. The teacher was requested to teach as she normally does and not to stage any special lessons for the purposes of this research project.

4.10. Summary

To summarise, this research project hopes to describe classroom practice in three primary science classrooms (grades 4 and 6) using evidence in the form of inscriptions, and to analyse it in terms of Bernstein's (1990) evaluative rules to determine the nature of this classroom practice. I hope to gain insight into how the practice is organised with respect to the principles of framing and classification. Further, to analyse the *what* of the classroom practice, using Dowling's (1998) four domains of practice in order to describe the nature of the *what.* Further, I hope to learn to what extent the classroom practice succeeds in communicating the recognition and realisation rules to learners, such that it is possible for them to acquire understanding of some contents of the esoteric domain of science in primary school.

Chapter 5: Language of description

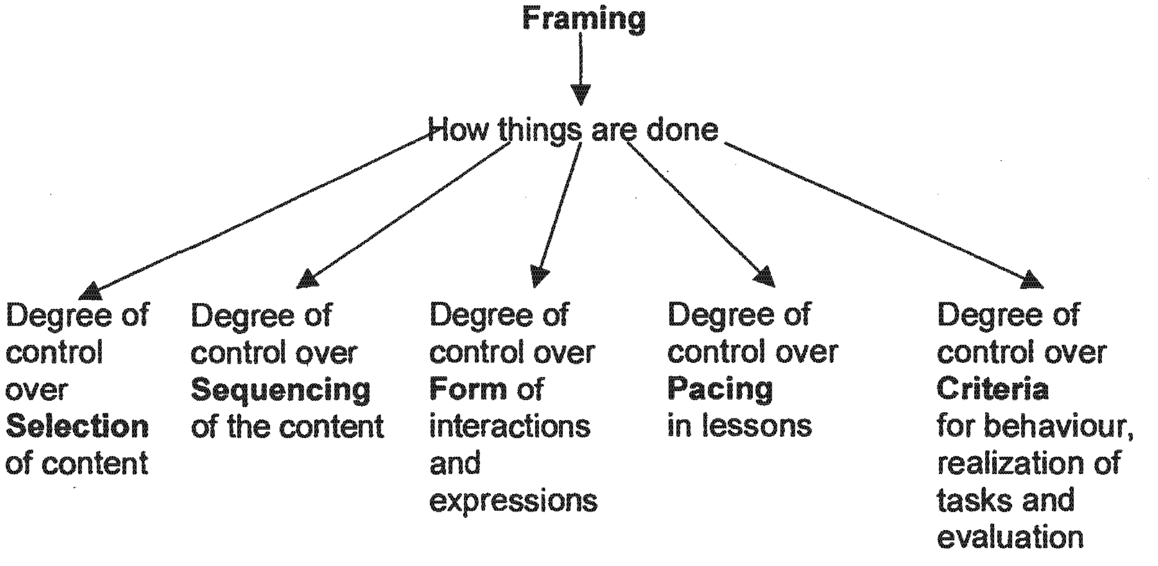
The task of this chapter is to construct a language of description that will connect the theoretical work done previously with the empirical phenomena. The notion of a language of description derives from the work of Basil Bernstein (1996) in which he draws our attention to the necessity of constructing the means by which the theoretical can grasp the empirical. That is, we need to construct the tools that enable us to transform the information we have gathered into data that is readable by our theoretical position as well as the relations between the data that would enable coherent analysis. Bernstein distinguishes between internal and external languages of description: The former is what we have referred to as a theoretical framework whilst the latter is what we have described above. In these terms what we are doing here, then, is constructing an external language of description.

This chapter will be structured in two major sections. The first part will deal with framing. In which an overview of the framing and its theoretical variables will be presented. The indicators for the theoretical variables for framing will follow this. The second part of the chapter will deal with classification in the same way. After each indicator I will provide references to the appropriate extracts from the classroom interactions and artefacts, which can be found in appendix 2

The nature of the realised content of the discourse was analysed with respect to Dowling's (1998) four domains of practice, that is, with respect to the esoteric, descriptive, expressive and public domains. This analysis and results will be dealt with in the next chapter.

5. 1. Framing

Fig. 5.1 Organising framework showing the theoretical variables for framing.



The indicators shown below stand as instances of realisation of the theoretical variables. They were developed from the empirical information derived from the classroom observations, teacher interviews and from the collection of artefacts produced by the teachers and learners. Where cases of the teacher or selected learners having more control over the contents or situation, a hierarchical relation exists. This is indicated as the hierarchical rule in operation.

5.1.1. Selection of content (degree to which teachers and learners have control over the selection of content)

This theoretical variable provides information about the control over the selection of the learning contents. This will give me information about *how* teachers and students go about selecting what is to be taught and learned.

5.1.1.1 Indicator for the selection of content

This indicator measures the degree of control over the selection of content of the discourse in the instructional context.

Instructional context
Discursive rules

Indicator	F++	F+	F-	F--
Selection of learning contents	The teacher determines/indicates the contents to be studied in each session. Learner suggestions are not invited nor incorporated.	The teacher determines the contents she considers as more important, accepting learner suggestions if appropriate	The teacher suggests the contents to be studied without referring to priorities and without obliging the learners to use them. Learners choose which of the teacher's suggestions to take up.	The teacher asks learners to select the contents to be studied and takes up their suggestions

See extracts pertaining to selection of content: Appendix 2, 1.1.1. pp 148-150.

5.1.2. Sequencing of contents (of lessons and tasks within each lesson)

This theoretical variable of framing provides information about the control over the sequencing of the contents to be studied. It gives information about who determines the ordering of the teaching and learning sequence and the extent to which the teacher and learners participate in this. It also gives us information about the order in which things are done. This may apply equally at the planning level (planning level) in which the order of the lessons is mapped out or at the level of the order in which different tasks and activities are carried out in individual lessons (enactment). This will provide information about *how* teachers and students go about selecting in what order things are to be taught and learned and whether there is flexibility within the sequence.

5.1.2.1 Indicator for sequencing of tasks

This indicator measures the degree to which the sequencing of tasks is controlled in the discourse, in the instructional context.

Instructional context

Discursive rules

Indicator	F++	F+	F-	F—
Order of tasks within the learning experiences	The learning experiences and tasks follow a rigid order determined by the teacher	The learning experiences and tasks follow an order determined by the teacher but which can occasionally be altered	The learning experiences and tasks follow an order planned by learners, with the teachers guidance	The learning experiences and tasks follow an order planned by learners

See extracts pertaining to sequencing of tasks: Appendix 2, 1.2.1. pp150-151.

5.1.3. Form (of interactions and expressions, such as, instructions, dialogue, group work etc)

This theoretical variable of framing provides information about the control over the form of the interactions in the classroom. This will give me information about *how* teachers and students go about communicating and interacting when things are to be taught and learned. This may apply equally at the planning level in which the forms of interaction and expressions are mapped out in advance, such as, in pre-determined sets of rules and instructions or at the level of the interactions which take place as tasks and activities are carried out in individual lessons (enactment).

5.1.3.1. Indicator for communicating instructions

This indicator measures the degree to which the form of communication of instructions is controlled in the relation teacher to learner in the regulative context.

Regulative context

Hierarchical rules: teacher-learner

Indicator	F++	F+	F-	F—
Communicating **instructions** for the task	Teachers instructions for the task are written on task sheets in advance and /or displayed (sometimes permanently)	Teacher tells learners instructions but they are not written or displayed	Teacher and learners negotiate instructions.	Learners formulate their own way of doing things without instructions from the teacher.

See extracts pertaining to communicating instructions: Appendix 2, 1.3.1. p152.

5.1.3.2. Indicator for communicating with others

This indicator measures the degree to which communication with others is controlled in the relation teacher to learner in the regulative context.

Regulative context

Hierarchical rules: teacher-learner

Indicator	F++	F+	F-	F—
Communicating with others	Teacher privileges a vertical and unidirectional relation of communication	Privileges a vertical and unidirectional relation of communication, with occasional interaction between teacher and learners	Privileges an interaction between teacher and learners although a vertical relation also occurs	Privileges an ongoing interaction between teacher and learners

See extracts pertaining to communicating with others: Appendix 2, 1.3.2. p152-154.

5.1.3.3. Indicator for communicating feedback

This indicator measures the degree to which communication of feedback is controlled in the relation teacher to learner in the regulative context.

Regulative context

Hierarchical rules: teacher-learner

Indicator	F++	F+	F-	F—
Communicating feedback about the processes and tasks	Teacher acknowledges all learners' efforts and gives feedback to individual learners or groups about specific contents of the tasks	Teacher acknowledges all learners' efforts and gives general feedback to the class about specific contents of the tasks	Teacher acknowledges learners' efforts and gives non-specific feedback about any aspect of the lesson (not necessarily about the contents of the tasks)	Teacher does not acknowledge learners' efforts and gives no feedback

See extracts pertaining to communicating feedback: Appendix 2, 1.3.3. pp154-155.

5.1.4. Pacing (time allowed for task completion)

This theoretical variable of framing provides information about the control over timing in the classroom. This provides information about the extent to which the teacher or learners have control over how long the learning sequence and activities and tasks should take. This will give me information about *how* teachers and students go about communicating how long the task should take and how much time they need to interact with the apparatus and materials and with each other during the teaching and learning. It will also provide information about whether there is time flexibility for the learners who work quickly and those who may need more time and how the teacher may achieve this. This may apply equally at the planning level (planning level) in which the time allotted for a sequence of work is time-tabled for a specific duration or at the level of the interactions which take place as tasks and activities are carried out in individual lessons (enactment).

5.1.4.1.Indicator for time allowed for exploring texts and themes under study

This indicator measures the degree to which timing is controlled in the discourse in the instructional context.

Instructional context

Discursive rules

Indicator	F++	F+	F-	F—
Time for exploring/discussing texts, themes and materials under study.	Time planned for exploration is rigorously kept	The teacher indicates the time for exploring but accepts occasional justifiable extensions	The time taken to explore is determined by the learners but the teacher presses them to finish the work	There is no predetermined time for the exploration; the time depends on the learners pacing and there is little pressure from the teacher.

See extracts pertaining to communicating time allowed for exploring texts and themes under study: Appendix 2, 1.4.1. pp155-156.

5.1.5. Criteria (how criteria are arrived at and communicated)

This theoretical variable provides information about the control over the criteria. This provides information about the extent to which teachers or learners have control over the criteria. This will tell me about how the criteria are arrived at and communicated.

5.1.5.1 Indicator for communicating criteria for learner social behaviour

This indicator measures the degree to which communication of the criteria is controlled in the relation teacher to learner in the regulative context.

Regulative context

Hierarchical rules: teacher-learner

Indicator	F++	F+	F-	F—
Communicating criteria for learner social behaviour	Rules of behaviour are determined by the teacher or institution and are written and/or permanently displayed	Teachers refers to rules or norms for behaviour but they are not written or permanently displayed	Teachers and learners negotiate acceptable rules of behaviour	Rules of behaviour are never referred to

See extracts pertaining to communicating criteria for learner social behaviour: Appendix 2, 1.5.1. p156.

5.1.5.2 Indicator for communicating criteria for realisation and assessment

This indicator measures the degree to which communication of the criteria is controlled in the discourse in the instructional context.

Instructional context

Discursive rules-evaluation criteria

Indicator	F++	F+	F-	F—
Communicating criteria for realization and assessment	The teacher specifies the criteria for a given task and they are told, written and /or displayed.	Teacher and learners negotiate the criteria for a given task.	Learners formulate their own criteria for a given task.	No specific criteria are formulated

See extracts pertaining to communicating criteria for realisation and assessment: Appendix 2, 1.5.2. p156-158.

5.1.5.3. Indicator for communicating criteria for satisfactory completion of tasks through dialogic evaluation

This indicator measures the degree to which communication of the criteria is controlled in the discourse in the instructional context.

Instructional context

Discursive rules –evaluation criteria

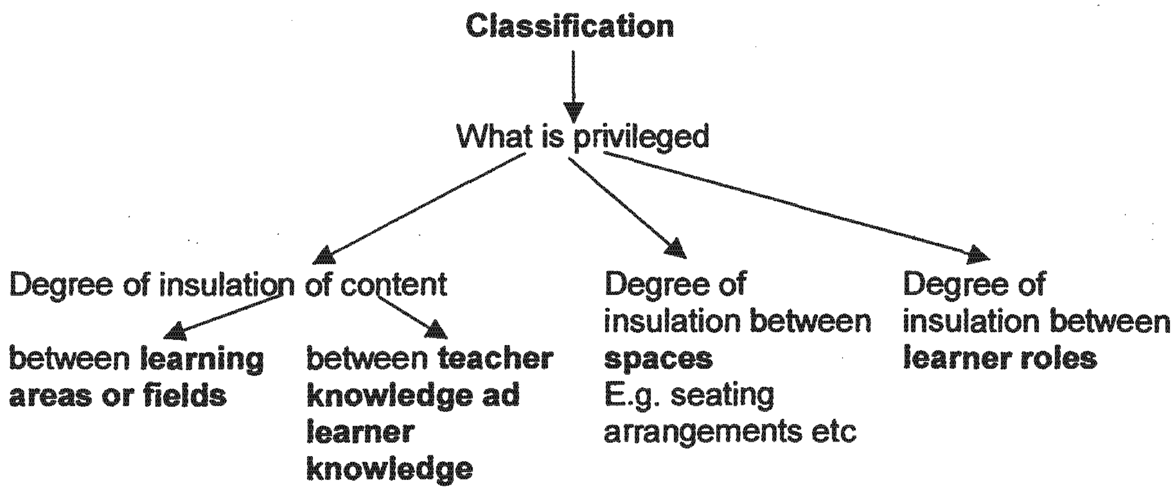
Indicator	F++	F+	F-	F—
Communicating criteria for judgement of satisfactory completion of tasks through dialogic evaluation	Teacher evaluates learners work individually and insists that tasks are fully completed (though this may take more than one try)	Teacher evaluates learners' work individually and accepts partially completed work.	Teacher does not evaluate learner's individual work.	No individual work is done (and therefore individuals are assigned a group evaluation- if evaluated at all)[1]

See extracts pertaining to communicating criteria for satisfactory completion of tasks through dialogic evaluation: Appendix 2, 1.5.3. pp158-159.

[1] This set of descriptors is concerned with the evaluation of the learner's **individual** performance. In some instances in classrooms the teacher may not call for individual work at all but may frame a task where learners work as a group and are evaluated as a group. Both these instances were seen in the classrooms studied. However, in other classrooms instances have been noted in which the teacher may provide a task, but will move onto the next activity without evaluating at all (without checking the learners work or referring to it in any way). I have chosen to regard the latter case as falling outside of the pedagogic device (framing and classification) since without evaluation, it could be argued that no teaching and learning has been seen to have taken place.

5.2. Classification

Fig. 5.2 Organising framework showing theoretical variables for classification.



<u>5.2.1 Degree of insulation of content (between learning areas)</u>

This theoretical variable provides information about the degree to which the contents of different learning areas are separated in the classroom discourse.

<u>5.2.1.1. Indicator for degree of insulation of content (between learning areas</u>

This indicator measures the degree if insulation between the contents of learning areas in the discourse in the instructional context.

Instructional context

Discursive rules –insulation of content (between learning areas)

Indicator	C++	C+	C-	C--
Learning contents	The learning areas contents are always studied in a non-integrated way	The learning areas are generally studied in a non integrated way but the teacher points out obvious links when they become apparent	The learning area contents are studied in an integrated way for the most part but sometimes learning areas such as maths are studied separately	The learning area contents are always studied in an integrated way.

See extracts pertaining to insulation of content (between learning areas): Appendix 2, 2.1.1. pp159-160

5.2.2. Degree of insulation of content between teacher knowledge and learner knowledge.

This theoretical variable provides information about the degree to which the learner and teacher knowledge is separated in the discourse.

5.2.2.1. Indicator for degree of insulation of content between teacher knowledge and learner knowledge

This indicator measures the degree if insulation between the contents of the teacher knowledge and learner knowledge in the discourse in the instructional context. The knowledge that the teacher transmits to the learners is taken to mean new knowledge for the learners.

Instructional context

Discursive rules- between teacher knowledge and learner knowledge

Indicator	C++	C+	C-	C--
Learning contents	There is no acknowledged relation between the learners' knowledge and the new knowledge under discussion	There is no clear relation between learners' knowledge and the new knowledge but learners' offerings are also acceptable	The learning contents always incorporates new knowledge as well as learners knowledge and the connection between the two is obvious	The learning contents rely only on learners' prior knowledge and contain no new knowledge.

See extracts pertaining to insulation between teacher's knowledge and learners' knowledge: Appendix 2, 2.2.1. pp160-161

5.2.3. Degree of insulation between spaces (seating arrangements)

This theoretical variable of classification provides information about the degree of insulation between the spaces occupied by learners the classroom. This will give me information about where tasks and activities will be carried out, where children are seated and therefore where they may move and with whom they may interact during activities. It will also provide information about whether there is flexibility for the learners and teachers in using the space, and how teachers and learners achieve this. This may apply equally at the planning level (planning level) in which the space allotted to learners and teachers and apparatus is pre-determined in the case of fixed classroom allocations and desk and workbench arrangements. Space allocations also apply at the (enactment) level of individual seating allocations which influence how interactions occur, such as group interactions, paired interactions and individual work during teaching and learning activities.

5.2.3.1. Indicator for degree of insulation between seating arrangements for different learners

This indicator measures the degree of insulation between the seating arrangements of different learners in the regulative context

Regulative context

Hierarchical rules: learner -learner

Indicator	C++	C+	C-	C—
Seating arrangements	Learners are separated by ability and have fixed seating arrangements over time.	Learners are separated by ability and have fixed seating arrangements which are changed around from time to time	Desks are arranged in separate groups but learners sit at any group.	Desks are randomly arranged and learners sit anywhere.

See extracts pertaining to Insulation between spaces (seating arrangements): Appendix 2, 2.3.1. pp161-162.

5.2.4. Degree of insulation between learner roles

This theoretical variable of classification will give me information about the degree of insulation of learners' roles. This tells me whether separate roles are designated to learners in the learning context and for what purpose.

5.2.4.1. Indicator for degree of insulation between roles assigned to different learners

This indicator measures the degree of insulation between the roles assigned to different learners in the regulative context

Regulative context

Hierarchical rules: learner-learner

Indicator	C++	C+	C-	C—
Different roles for group work	Separate roles are designated to particular learners and they remain fixed over time.	Separate roles are designated to particular learners. The roles are changed periodically according to a rotation timetable.	Learners may assume a certain role for certain tasks, on occasion For example, one learner might read for the rest of the group if there is only one paper available to the group.	No roles are designated. Learners roles are interchangeable at all times.

See extracts pertaining to degree of insulation between learner roles: Appendix 2, 2.4.1. pp162-163

5.3. Summary

These indicators were derived from the theoretical variables and empirical observations in the three classrooms. They provide the tools for measuring the strength of the framing and classification, which in turn allows a rather delicate description of the *how* and the *what* in the three classrooms of this study.

Chapter 6: Analysis and results

This chapter will be presented in three parts. The first part presents an analysis of the data that shows the strength of framing and is followed by a table of results for framing. The second part presents an analysis of the data which shows the strength of classification and will be followed by a table of results for framing . This analysis constitutes a description of the pedagogic practices (the *how* and the *what*) in terms of Bernstein's (1996) theoretical variables for the evaluative rules of the pedagogic device.

The third part presents an analysis of the realised texts in terms of Dowling's (1998) four domains of practice and is followed by a table of results. This analysis constitutes a description of the nature of the realised discourse (the *what*).

6.1. Analysis with respect to framing

Framing, as has been explained in the previous chapter, refers to the *how* of classroom practice. Framing has variations in terms of the degree of control over the **selection of content**, the degree of control over the **sequencing** and the **form** of the content. It also refers to the degree of control over **pacing** in the classroom and the degree of control over the **criteria** for social behaviour, realization, and evaluation. In analysing the pedagogic discourse in these three classrooms, I further sub-divided the **form** of the content into instructions, communication, and feedback.

In the analysis of framing I will refer to all three classrooms together, as there is generally a high consistency of similar values for framing in all three. Where there are differences, I will discuss these separately in more detail.

6.1.1. Selection of content

In all three classes the pedagogy was very strongly classified with respect to content selection at both the planning and enactment level. At the planning level the teacher planned a selection of the content and activities from a number of different resources at her disposal; from textbooks, learning programmes produced by NGOs and so forth, which are in line with C2005. At the enactment level the activities were selected for the day by the teacher and in the classroom interaction the teacher constantly referred to the relevant contents to be studied, both verbally and by pointing to the texts.

6.1.2. Sequencing of content

In all three classrooms, the framing was strong with respect to control over the sequence in which the content of lessons and activities were taught/learned, particularly at the planning level. This indicates that the teacher had control over the order in which things were done in the classroom, at the level of planning.

6.1.3. Form of interactions and expressions

6.1.3.1. Communicating instructions

In all three classrooms the framing was strong to very strong on degree of control over the instructions, at the planning level. This means that the teacher gave instructions. Sets of task instructions were clearly written down on individual worksheets and task cards and sometimes displayed prominently in the classroom. In class A, at the planning level, instructions for tasks were also conveyed verbally by the teacher to the whole class, for example learners were told to make the light bulb light up using the electrical components and this was followed by a set of written instructions for each group or learner on the task cards (enactment).

6.1.3.2. Communicating with others

In all three classrooms the framing was weak in terms of the degree of control over the classroom communication at the enactment level, indicating that the teacher encouraged interactions between the teacher and learners and amongst the learners themselves. However a vertical relation also occurred at times between the teacher and learners and between learners themselves, especially when roles were assigned to individual learners.

This indicated that the teacher maintained her overall control of the classroom but encouraged free interaction to take place when appropriate.

6.1.3.3. Communicating feedback

In all three classrooms the framing was strong in terms of the degree of control over communicating feedback to learners about the process of learning and the form and content of tasks at the level of enactment. This means that the teacher gave specific feedback about the content of tasks to selected learners in the classroom situation whilst activities were under way. It was not possible within the scope of this project to determine whether after a period of time for example, at the end of a learning programme or sequence of work, each and every learner received formative feedback, nor was I able to tell what form it might take.

6.1.4. Pacing

6.1.4.1 Time allowed for exploring texts and themes under study

In class A there was weak framing in terms of the degree of control over pacing at the planning level, but strong framing at the enactment level. The weak planning level framing showed that the teacher planned for and implemented a flexible approach to pacing. This referred to instances where learners were not able to finish their tasks within the time allocated to the lesson, in which case the teacher allowed the learners to finish their tasks over a number of days and they were allowed a number of tries in order to arrive at a satisfactory realisation. This took into account the different paces at which learners worked in order to complete their tasks. This teacher made additional time available after school for learners to do this. At the enactment level the teacher paced the lesson so that the majority of the learners could complete their tasks and so that there was time to round off lessons and pack away equipment in the time available. This ensured efficient management of class time and ensured that the slow learners did not slow the pace of learning for the majority.

In classes B and C there was very strong pacing at the enactment level in terms of pacing the teaching and learning to fit into the allotted time in the lessons. Again, this ensured efficient management of class time but it is not clear how slower learners are catered for in terms of allowing additional time for task completion.

6.1.5 Criteria

6.1.5.1. Communicating criteria for learner social behaviour

In class A, I was unable to ascertain whether the rules for social behaviour are communicated to learners within the scope of the two lessons observed.

In class B the framing was strong with respect to the degree of control over the communication of the rules of social behaviour at the level of enactment. This meant that the teacher reminded learners of the rules for social behaviour in the lesson. This was used to smooth classroom relations and management when learners were working independently as groups and were not under the close supervision and scrutiny of the teacher.

In class C the framing was very strong at the planning level and weaker at the enactment level with respect to the degree of control over communication of the rules of behaviour. In this case the teacher reported that the rules had been generated collaboratively by the teacher and learners (weak framing) and then written and displayed on the classroom walls (strong framing). *(See appendix 2: plate 8. p180)*

The act of writing and displaying the rules caused the rules to become institutionalised at the planning level in the classroom and therefore they came to represent the voice of authority even though they had been developed in collaboration with the learners. This resulted in a voice of authority being present, as well as 'buy-in' by the learners since they had helped generate the rules. The list of rules served as a constant reminder to learners that the rules are always in play in every situation in the classroom (strong framing) without the teacher having to remind them of the rules during classroom activity. These criteria contributed to the formation of the correct socio-affective dispositions, described by Bernstein (1996), and which learners must acquire for successful realisation of tasks

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6.1.5.2. Communicating criteria for realisation and assessment

In all three classrooms the framing was strong, to very strong with respect to the degree of control over the communication of the criteria for realisation. This meant that the teachers had formulated criteria for realisation and had communicated these to learners verbally or in written form before the learners attempted the task.

In class A at the planning level, generic criteria for realization for five different forms of communication (speaking, making models, drawing, writing, and acting out) were displayed permanently in the classroom. *(See appendix 2:plates 9a, 9b, and 9c, pp181-183)* The teacher would then contextualise these generic criteria for particular tasks. The learners wrote these contextualised criteria onto their task cards before they attempted the task. *(See appendix 2: Plate 6. p178).* These served as reminders to the learners who referred to them whilst completing the task. The teacher in turn used the criteria to guide her facilitation of the lesson and as pointers for feedback to learners. In this respect the criteria constituted a powerful tool for the teacher and learners in the classroom context. The use of generic criteria for different forms of communication set a standard within the classroom by which all learners were evaluated, produced class cohesiveness and provided a sense of fairness.

6.1.5.3. Communicating criteria for satisfactory completion of tasks through dialogic evaluation

In all three classrooms the framing was strong to very strong in terms of the degree of control over evaluating individual learner task completion and realisation at the level of enactment. This meant that the teacher evaluated individual learners' work and expected them to complete their individual tasks, created conditions for this to happen and gave suitable instructions and ongoing feedback.

Communicating criteria for satisfactory completion of tasks and dialogic evaluation was achieved in different ways in two of the classrooms. In class A the teacher seated the learners in three different groups according to their 'ability'. When the work was set she spent more time at the group where learners struggled with understanding or were likely to take longer because of language or social problems. Each learner had to submit his or her own work, which the teacher evaluated. The teacher inspected the work and if she was not satisfied she allowed the learners to correct and submit their work again. She allowed the learners a number of attempts until she was satisfied. She also scheduled time after school for learners to receive more individual attention in order to complete their tasks.

In Class B the teacher and the learners together evaluated certain aspects of the work by displaying some evaluation criteria on the chalkboard. Then the learners had to judge whether different groups had achieved the required understandings during a report-back session.

In class C the learners were given the opportunity to first complete the task as a group task. This completed task was then submitted by the group and displayed on the chalkboard. The teacher with the help of the learners evaluated the task. This was done dialogically and as a whole class exercise. Thereafter the evaluated task was returned to the group. The learners used this document as a corrected draft from which they completed their individual tasks.

In general the pedagogy in all three classrooms can be described as strongly framed with respect to selection, sequence, pacing, and criteria. Two aspects of form are also strongly framed with respect to instructions and feedback. However the form of communication between teachers and learners was weakly framed, indicating that open communication between teachers and learners and also amongst learners is favoured.

6.1.6. Summary of the analysis with respect to framing

We can therefore describe the ***how*** of pedagogy in these classes, in general, in the following way:

The teachers have selected a planned sequence of content, which is implemented within the timetabled time constraints but also takes into account the pace of slower and faster learners, so that learner's pacing needs are met. Instructions for tasks are communicated. The teachers provide instructions (usually written ones) for tasks and activities. The teachers communicate the criteria for realization before the tasks are done and specific feedback is communicated. The teachers evaluate the learner's work as part of the teaching process. These teachers also encourage open dialogue between all members of the class and between the teacher and the learners. The classrooms are well disciplined and the teachers remind learners about acceptable social behaviour.

Fig. 5. 3 Results of framing

Indicator	Class A Planning	Class A Enactment	Class B Planning	Class B Enactment	Class C Planning	Class C Enactment
Selection						
1.1.1. Selection of content	F++	F++	F++	F++/F+	Not seen	F+
Sequencing						
1.2.1 Sequencing of tasks	F+	Not seen	F+	Not seen	F++	F+
Form						
1.3.1 Communicating instructions	F++	F+	F+	Not seen	F++	F+
1.3.2 Communicating with others	Not seen	F-	Not seen	F-	Not seen	F-
1.3.3 Communicating feedback	Not seen	F+	Not seen	F+	Not seen	F+
Pacing						
1.4.1 Time for exploring texts	F-	F+	Not seen	F+	Not seen	F++
Criteria						
1.5.1 Criteria for social behaviour	Not seen	Not seen	Not seen	F+	F++	F-
1.5.2 Criteria for realisation and assessment	F++	F+	Not seen	F++	F++	F+
1.5.3 Criteria for dialogic evaluation	Not seen	F++	Not seen	F++	Not seen	F+

6.2. Analysis with respect to classification

Classification as stated before, refers to the *what* of the classroom discourse. Classification, in terms of Bernstein's (1996) thesis, refers to the degree of insulation between contents, spaces and people. This was analysed in terms of the variation found in the degree of insulation between **learning areas** or fields of practice, and the degree of insulation between **teacher and learner knowledges**. The variations in the degree of insulation between classroom **spaces** was analysed with specific reference to seating arrangements. The degree of insulation between learners, in terms of the **roles** assigned to different learners in the learning situation, was also analysed.

The nature of the **content specialisation** was analysed with respect to Dowling's (1998) four domains of practice, that is, with respect to the esoteric, descriptive, expressive and public domains. The analysis was carried out by examining the learners' and teachers' inscriptions over the period of the lessons observed. It was not possible to analyse each inscription but rather examine the process by which a number of inscriptions produced by the teacher and the learners led to the learners' development of specialised scientific concepts and forms of expression (or not, as the case may be).

<u>6. 2. 1. Degree of insulation of content</u>

<u>6.2.1.1 Degree of insulation between content of different learning areas</u>

In Class A there was weak insulation between the content of learning areas.
In the interview and discussions, this teacher told me how she constructed a curriculum in the form of a narrative, which connects to other learning areas. Firstly she defines a narrative as having an interesting starting point, a middle section that contains some content, and then some logical end point. She started by constructing a narrative, in one of her content areas, for example, in science. At the same time she started a parallel narrative in another content area but this narrative must have some obvious connection to the first narrative. For example, the narrative in science might be about the plants and animals living on the surface of the earth whilst the parallel narrative is about mining under the surface of the earth and bringing the ore to the surface of the earth. At some point she

might ask learners to make a drawing showing the plants and animals that live on the surface of the earth and what they will need in order to live there, in the context of a *science* task. At this point the learners may well make the connection to the parallel narrative and will add a mine headgear into their diagram about plants and animals (and coco-pans rising to the surface as well as mine shafts under the ground). And this is what I saw in the classroom during the pilot study.

The teacher claimed that the learners were able to make the connections between learning area contents themselves. The teacher gave only the key words for the *science* part of this task as it took place in the science lesson and not for the mining part, which took place some time before in the social science lesson. Furthermore she claimed that although she worked on making narratives that do connect in her content subjects, she does not necessarily consciously point this out whilst teaching. However she claimed the learners are able to make these connections for themselves.

This teacher also did not have separate language lessons in her curriculum. Instead she used key words as new vocabulary and taught the learners how to make other sentences with them (not just in the science or geography context) and how to punctuate them. The different genres of writing were taught and employed within the content of the learning areas. Reading tasks were also done within the context of the learning area narratives.

In classes B and C, no evidence was seen of the degree of insulation between the content of different learning areas in these classes.

6. 2. 2. Degree of insulation of content

6.2.2.1. Degree of insulation between teacher knowledge and learner knowledge

In all three classes there was weak content insulation between teacher and learner knowledge at the level of enactment. In class A, at the planning level, the teacher often referred learners to the television programmes that they watch, which have some bearing on the content which is being studied. She actively tried to find out what the learners already know. In all three classrooms, at the enactment level, during classroom interactions, learners were encouraged to relate their own experience and knowledge to the new knowledge under discussion.

6.2.3. Degree of insulation between spaces

6.2.3.1 Degree of insulation between seating arrangements of learners

Space was analysed in terms of the degree of insulation between the seating arrangements of different learners in the classroom. In class A the classification was strong in terms of the insulation between the seating arrangements on both the planning and enactment level. There were two levels of seating arrangement determined by the teacher in this class.

On the planning level in class A, the seating was divided into three large blocks of 15 to 20 learners sitting in rows of tables facing each other with space for the teacher to move up and down the rows. Each block represented a different 'ability' group. The teacher explained that those in the 'slower ability' group worked at a slower pace because of reading, writing, and social difficulties and in a few cases certain learning difficulties. As individuals progressed over the year and their skills improved they were moved into the second group and similarly as some learners in the second group experienced difficulties (mostly due to social factors) or showed improvement they were moved into other groups, the majority moving on to the third group. The third group was made up of learners who were not experiencing any difficulties and were able to complete their tasks with minimal help. The flexible nature of this arrangement, allowing movement between groups, helped the teacher to identify and keep track of the progress of learners and to focus most of her time and attention on the group with the most difficulties. It also gave the fast group more independence to finish the tasks on their own. The movement between the groups allowed learners to progress to the next stage of independence when they were ready, so taking into account the differential progress of learners.

At the enactment level in class A the teacher assigned learners to smaller groups of six within the larger groups described above. This was accomplished without changing the seating arrangements. The learners were already sitting in rows of tables facing each other. So three learners were grouped with the three learners facing them across the table space. This arrangement allowed the efficient sharing of materials as well as the close proximity needed for group work. It also provided sufficient table space for equipment and the storage of the learners' files. *(See Appendix 2: plate 11. p186)*

In class B the classification was very weak with respect to the degree of control over the seating arrangements at the level of enactment. The tables/ desks were loosely arranged in groups and the learners sat where they pleased in groups of five or six. The teacher could walk between all the tables with ease. The seating arrangements were weakly classified since learners were not assigned particular individual seats and/or designated areas of the classroom. There may be a number of reasons to explain this. Firstly these learners (grade 6) are older than those in the other two classes (grade 4) and friendship groups may work better for classroom management of these learners, who were coming into their teens. In this particular class of 60 learners, timetabling constraints resulted in the class being full size for some lessons and half size for other lessons in which they were divided between two different science teachers. During one of the lessons I observed, the class consisted of 30 learners and in the other lesson I observed the class was full size with 60 learners. Under these conditions it would be difficult for the teachers concerned to maintain stable groupings of learners and this may be the reason why it is not seen in this class.

In class C the classification was very strong with respect to insulation of spaces in terms of learners seating arrangements at the enactment level. The learners were arranged in groups of 4 at pairs of tables. The learners were designated to given groups, which were permanently maintained, and roles were assigned as explained earlier. There was an exception in the case of one learner who was placed at a desk on his own. The teacher explained that he had attention and learning difficulties and was better contained sitting on his own near her desk. The teacher could move freely between the groups. At the front of this classroom near the chalkboard the teacher used a shelf as a place from which to dispense equipment. *(See Appendix 2:plate 12. p187)*

In classes A and C where the classification was strong, the teachers had arranged the spaces and seating rationally and strategically to serve both the practical purposes of classroom management as well as the perceived educational needs of the learners. In class B, where the classification was weak there may have been practical constraints to specifying structured seating arrangements due to the class size and timetabling changes as already described. All of these teachers had organised their classroom space rationally so that they were easy to manage.

6.2.4. Degree of insulation between learner roles

6.2.4.1 Degree of insulation between the roles of different learners

In classes A and C the classification was strong to very strong in terms of the insulation between different roles assigned to learners. In class A the teacher seated the learners in three large 'ability' groups but within these larger groups the learners were grouped in sixes for sharing equipment and materials, and were assigned roles on a rotating basis. In contrast, in class C, the teacher seated the learners in groups of four. Each group had a reader/writer role assigned to a learner who could read and write well. When the task was handed out, the reader/writer lead the task by reading it out. The group did the task together first, and told the reader/writer what to write or draw. The tasks completed by the group, were then scrutinized and corrected in an evaluation and feedback session with the teacher. Finally the task was returned to the group and used as a draft from which each learner had to complete the task individually. In class C, as I have described, the roles remained fairly fixed especially in the case of the reader/writer.

There appear to be advantages to both of these systems. In Class A the roles are changed on a rotating basis and come into play when the learners are working in autonomous groups doing tasks. The advantage, as the teacher explained, is that each role presented a different challenge to learners and they each had a chance to rise to the challenge of a different role and its responsibilities.

However, in class C, the teacher has grouped the learners deliberately so that each group contained a learner who could read and write. In this class there are many learners who struggled with reading and writing and by grouping the learners. In this way the teacher ensured that the tasks were read and interpreted by the reader/writer for the rest of the group so that tasks could go ahead independently in each group. In this case the reader/writer also became a facilitator, interpreter, explainer and a role model to the other learners in the group. She/he became the apprentice teacher whilst group tasks were being done. Similarly the reader/writer recorded what the other learners told her to write or draw and in so doing modelled the realization of the writing/drawing task. This in turn produced a first draft inscription, which incorporated the teacher's verbal evaluation and feedback, and which learners could refer to as they completed their individual tasks. This may have been a way to ensure that learners completed their tasks independently rather than the teacher working through an example on the board with learners, and more efficient than working with the less proficient learners individually. However the question arises about whether the fixed nature of the reader/writer role in particular, is not a limiting factor for less proficient learners in the group, as their own reading and writing skills emerge. It may also be a limiting factor for the more proficient learner who is tied to the pace of the less proficient learners. The knowledge gained by the group may also be limited by the reader/writers own knowledge limitations.

It was clear that these teachers have used and assigned the roles strategically in their classes to take care of factors concerning learners differential needs and proficiencies and the need to help learners to work more independently, and ensure the smooth running of group activities.

Fig. 5.4 Results of classification

Indicator	Class					
	A		B		C	
	Planning	Enactment	Planning	Enactment	Planning	Enactment
Content insulation 2.1.1. Between learning areas	C--	Not seen	Not seen	Not seen	Not seen	Not seen
Content insulation 2.2.1. Between teacher and learner knowledge	C-	C-	Not seen	C-	Not seen	C-
Insulation between spaces 2.3.1 Between seating for different learners	C+	C+	Not seen	C-	C++	C++
Insulation between learner roles 2.4.1 Between roles of different learners	C+	Not seen	Not seen	Not seen	C++	C++

6. 3. Analysis for classification with respect to the four domains of practice

In order to analyse the three classrooms with respect to the four domains of practice (Dowling 1998), it was necessary to describe the development of the lessons through the inscriptions to see whether any scientific concepts were developed which would fall into the esoteric domain of science. However, whatever the teacher chooses to recontextualise for the science classroom, whether it emanates from the esoteric field or from the everyday knowledge of the public domain is deemed to be school science. This is because the teacher is positioned as a science teacher and therefore what is produced in the classroom is deemed to be an instance of the discipline. It has a symbolic meaning for the learners and they are deemed to have learned science if they produce acceptable texts. Therefore it becomes necessary to consider what kind of knowledge structure is transmitted and received. Bernstein's (1999) notion of horizontal or vertical discourse was used in conjunction with the four domains of practice. Used together these theories allowed analysis, which gave clues to whether the contents fall within the esoteric domain of science. The classes will be described in detail to illuminate the direction in which the classroom discourse moved, towards the esoteric domain of practice, or not, as the case may be. A sample of learners work identified by the teacher as highly acceptable examples of realisation were also analysed. This provided insight into the nature of the realised discourse.

6. 3. 1. Understanding the nature of the classroom discourse

In classes A and C learners were involved in discussions about energy, fuels and electricity as an orientation to the practical work. In the practical work the learners were asked to connect up two wires, a light bulb and a cell to make the electric bulb light up. They named and described electrical components familiar to them and those of the circuit under study. Then they took part in the practical activity and all succeeded in making a circuit in which the bulb lights up. After that the learners made a labelled drawing to show how they had connected up their components. And finally they filled in the missing words in the sentences (written inscription), which described different aspects of the task. The priority of this task was to light the light bulb and draw and describe. The concept of a circuit was not named or explained *(See appendix 2: Plate 14. p189)*

This task contents were located in the public domain and as the lesson progressed there was no evidence of a movement towards the esoteric domain of science. For example, no explanation by teachers or learners was offered, to help learners understand *why* it is necessary to connect the components in a certain way so as to establish a circuit. It was not explained that the circuit, a continuous pathway for the electricity, is a prerequisite to allow the flow of charge from an energy source to a light bulb and back to the source. Nor were there any other explanations of the nature of an electric circuit. No hierarchies were developed, for example there were no generalised categories, such as, all circuits require an energy source. Although learners were asked to fill in words in a sentence describing the sequence in which the electricity moved from the cell through the wires and components and back to the cell, the teacher did not elaborate or explain the universal concept of a circuit and that the movement of charge from a source through a conductor is an electrical current. Nor was there evidence of learners developing their own understanding by predicting and then testing to find out whether the bulb will light up when the components are arranged in different ways or when the circuit is broken or discontinuous.

The lesson contents were located in the public domain rather than in the esoteric domain of science. This can be explained by the notion of a horizontal discourse. It appears that in these lessons the teachers facilitation produces a discourse not from the esoteric field of science with its reference to a system of hierarchies and field of knowledge that uses specific methods and thought patterns, but rather a horizontal discourse, as seen in domestic practices. Here I need to further define what I mean by a domestic practice and explore how it differs from a scientific field of practice. I will explain thereafter, how the teacher's facilitation is like the communication of a domestic practice. I will also discuss its effect on learning.

Domestic practices, according to Bernstein (1999), are communicated through a horizontal discourse. They are learned by an exchange of relations between people, by an individual watching and doing what other people do in order to reproduce certain practices for the good of the family or community. For example, domestic practices will require that those engaged in selecting and preparing food do so in such a way that the food selection ensures a healthy diet and that it is prepared in a hygienic and appetizing way, so that the members of the family or community receive the correct benefit from it. Similarly those engaged in using electrical appliances in the domestic situation generally reproduce practices, which ensure that people know *how* they are used effectively, safely and efficiently. Domestic practices, by nature, are highly contextual and represent a collection of segments of knowledges. Contextual domestic fields of practice are driven by moral, ethical and socio-cultural imperatives.

The esoteric field of science, on the other hand, employs different practices and is driven by different imperatives. The practices in the field of science grow out of, and refer to and develop from, a system and field of accepted knowledge and methods and ways of thinking connected by theory. The imperatives that drive the field are the need to explain the material world and to push forward the limitations of the field's own discursive structure and to arrive at universal understandings and acceptance, resulting in a linked theoretical system of abstracted and decontextualised universals. These universals are employed in explaining, predicting and testing. They are not bound by context and can therefore be applied to many different situations.

However, in these classrooms the object of the teaching/learning was to develop a set of practices for lighting a light bulb and so forth; a set of practices that is largely domestic in nature rather than esoteric in nature and which results in each learner reproducing similar constructions of the circuit rather than exploring many different ways to light the light bulb or understanding why it lights up at all. For example, when the learners have difficulty in lighting the light bulb (because they attach both wires to the same pole of the cell or that of the light bulb), the teacher does not address this by explaining the need for a pathway for electricity to flow through the cell and the bulb and back again, a universal principle of the circuit, thus establishing the concept of a *circuit*. Rather, she simply describes, in practical terms, that there are two sides or poles to each component and that each pole must be connected to a separate wire. Moreover the learners are not required to reproduce/produce explanatory texts, rather, they are required to produce procedural texts, which refer to the set of domestic practices to be mastered and reproduced.

But in these classrooms we see an interesting paradox. The teacher's facilitation demonstrates a domestic perspective. However the materials sourced by the teacher, and in most cases used ready-made, were designed and written by authors who design activities and write from an esoteric perspective. The materials therefore transmit the regulative principles of the esoteric domain.

In classes A and C, for example, the teacher made her selection of material from a range of resources. These materials, such as worksheets and texts, were ready-made or the teacher made them up from the textbook or learning programme using the ready-made formats as a guide. The worksheets and texts are recontextualised from the field of science in that they contain the logical and reasoning frameworks, which derive from the regulative principles of the field. They also contain the structures essential for processing information, such as, pictures, reports, sequences of instructions and so forth. So the materials reflect to some extent the regulative principles, of the esoteric domain.

However in all three cases, by and large the teacher's classroom facilitation reflected a horizontal discourse as seen in domestic practices. This can be further seen in that all three teachers relied mostly on oral transmission in the science classes. They spent time on helping learners to become familiar with new words and terms, which often came before the experiences (practical work). They also spent time on helping learners to become familiar with different forms of expression, such as reporting or recording or drawing.

In Classes A and C the teacher did not relate the different experiences to any principles or concepts which would connect the different experiences, such as relating the lighting of a light bulb to the principle of electricity flow in a circuit.

In Class B the teacher attempted an explanation of static electricity but did not fully elaborate. In the scope of this research project it was not possible to tell whether at some later date when the learners had gained further experience, the teacher might have returned to a fuller explanation and this was a particular limitation of this research project.

In these classes, the teachers regarded successful realisation to have taken place when the learners could use the new words and terms correctly in the form of expression specified, or example, in labelling their diagram with the correct words and terms, or writing a set of instructions (determined by the regulative discourse recontextualised from the field of science). This again suggested that the acquisition of a horizontal discourse was considered acceptable recognition and realisation.

6.3.2. Learner acquisition via the classroom discourse

We see further evidence of the effects of a horizontal discourse in the following examples. In class C the second lesson was about static electricity. The teacher introduced the term static electricity and elaborated it in terms of the example of a person's hair standing on end in dry weather. Thereafter the learners talked about their own experience of static electricity and proceeded to carry out an activity in which they had to rub (electrically charge) a plastic ruler with a cloth and then demonstrate electrostatic attraction by picking up small pieces of uncharged tissue onto the charged ruler. The learners completed the task by answering a guided self-assessment worksheet. The worksheet contained sentences to be completed, such as; 'I learned a lot about…' 'I really liked it when we...'; I want to find out more about...'; 'This is a drawing of what I liked best…'; *(See appendix 2: plate 13. p188)*. In this exercise, the way that learners completed the task gave a range of answers, which indicate realisation in terms of the horizontal discourse and public domain knowledge. Some learners reflected on the subject matter, such as the fact that different materials could be used to demonstrate static electricity, and made sketches of rulers with papers attracted to them. However other learners made no connection at all to the subject matter. They wrote statements such as, 'I liked it when we were talking'. One learner produced a drawing showing a self-portrait with the caption; 'This is me. I like to play', rather than reflecting on the science task and showing his conceptual understanding of it. *(See appendix 2: plate 13.p188)* Indeed the questions themselves did not lead the learners to expose their understanding, nor lead them to try and explain or develop their own hypothesis about *why* the ruler picks up pieces of paper. It could be argued here that the teacher had not established a conceptual framework for the learners to draw from in order to explain. Nor did the teacher provide an alternative by encouraging the learners to make their own hypothesis about why the paper is attracted, followed by an explanation of the accepted scientific hypothesis.

The absence of a conceptual framework is an effect of a horizontal discourse with its associated weak grammar. In this lesson, there was no explanation leading to development of the concept of static electricity (work done by the force of attraction or repulsion caused by electrically charged insulators). There was no explanation of why the ruler becomes electrically charged in terms of electrons being rubbed onto or off the materials. The resulting electrostatic force was not explained in terms of the differential of electron charges on different objects. The learners were simply exploring a natural phenomenon. The drawings and writing produced by the learners did not go beyond the context of the activity and their own experience of it. The writing tasks referred to only the naming of parts and the procedural aspects of the task. Once again the perspective acquired was domestic and contextual, resulting in learners operating with unspecialised public domain knowledge.

A further example was found in class B, in the lesson about static electricity. In this lesson the teacher attempted an explanation about static electricity, which brought into play some science concepts. In lesson 1, the first part of the lesson consisted of an orientation to the topics Energy and Electricity. The practical activity that followed was to generate static electricity and demonstrate electrostatic attraction, using plastic rulers and pieces of tissue. This was a similar lesson to that described in class C. The learners' writing task consisted of writing a set of instructions describing how to produce static electricity and to demonstrate the force of attraction between the ruler and the uncharged pieces of tissue. In this lesson the teacher attempted an explanation of static electricity in terms of charges.

T 'I want you to tell me what happens when something gets charged. First thing you must do?'
L 'Rub it.'
T 'Yes rub it. Second thing you must do- put it on pieces of paper- then pick it up. What happens? Electrical charges... because of friction.... electricity moves through here and then attracts the other object.'
(Extract taken from Class B, Lesson 1, 14/08/02, and 11.30.a.m.)

However this explanation does not elaborate the concept of charge, which is due to an excess or dearth of electrons on the object as a result of electrons being rubbed onto or off of the materials. The forces of repulsion and attraction are not explained as the effects of the interaction between differentially charged objects. The concept of neutral objects (the pieces of paper) is not explained nor is the effect of charged objects on these. The writing task, requiring reflection by learners on their own learning, did not result in learners referring to their knowledge of scientific concepts of any kind and so realisation on the part of the learners was in terms of public domain knowledge. This too reflects the effects of a horizontal discourse.

6.3.3.Results for learner realisation

The table below shows results of the analysis of a selection of the learners' realised texts according to Dowling's (1998) four domains of practice. Copies of the realised texts have been provided in appendix 2. In the table below the name of the text (completed worksheet) has been recorded as well as a plate reference number. The reference number corresponds to the plate number of the original text, which can be found in: *Appendix 2: plates 15-31, pp 190-206.*

Fig 6.1 Table of results for learner realisation

	Domain of practice
Class A Realised texts	
Plate 15: Diagram of an electrical circuit	Public domain
Plate 16: How I made the bulb light up	Public domain
Plate 17: Who or what is using energy	Public domain
Plate 18: Mining in South Africa	Public domain
Class B Realised texts	
Plate 19: Types of energy	Public domain
Plate 20: What is energy?	Public domain
Plate 21: The different forms of energy my body uses	Public domain
Plate 22: Where does my energy come from originally	Public domain
Plate 23: Getting stored energy out	Public domain
Plate 24: Is electricity useful?	Public domain
Plate 25: How coal is made in the earth	Public domain
Plate 26: The power station	Public domain
Plate 27: Explain in your own words how coal was formed	Public domain
Class C Realised texts	
Plate 28: Electrical energy	Public domain
Plate 29: Diagram of electrical circuit	Public domain
Plate 30: Self assessment	Public domain
Plate 31: Static electricity	Public domain

6.3.4. Summary of the nature of the discourse

In these science lessons, it would seem that the discourse is only scientific in terms of the regulative practices: the words such as cell, circuit, light bulb and wires are scientific as well as everyday language terms. The form of the diagram with labels and the notion of doing science via practical activity, appear to be scientific. The worksheets are structured according to scientific regulative principles. But without the necessary concept and thought development by way of explanation, leading to accurate prediction and testing over several cases (moving towards understanding of a universal), these lessons do not appear to fully serve the esoteric domain of science in the instructional discourse.

Classes A and C were weakly classified in terms of in terms of both content and expression. This means that all the inscriptions recorded, both for the teacher and the learners, were located in the public domain and dealt with unspecialised knowledge with respect to the esoteric domain of science, although the content had been recontextualised for the science classroom.

Class B was weakly classified in terms of content and expression (with respect to the esoteric domain of science) for almost all inscriptions, for both learner's and teacher's inscriptions. However, in this class the teacher offered one explanation in one of the lessons, which falls into the expressive domain, (detailed in 6.3.2 above). In this inscription the content was strongly classified but the form of expression was weakly classified. In this inscription the teacher attempted to explain static electricity with reference to the scientific concepts of friction, electrical charges and forces. The teacher's attempt fell short of a fully elaborated explanation of the concepts. She simply used the terms described above without an explanation of their meaning and their relation to static electricity and in this respect it represents a degenerate form of expressive domain content.

6.4. Summary of the analysis with respect to classification

This summary of the analysis with respect to classification takes into account Bernstein's (1996) evaluative rules, Dowling's (1998) four domains of practice and Bernstein's (1999) horizontal and vertical discourse.

In general the ***what*** of the teaching and learning in these classrooms can be described in the following way. In general, all three classrooms were weakly classified with respect to content insulation (where evidence was available). Although the teachers in all three classes were the selectors of the material, indicated by strong framing, they took into account learners' knowledge in classroom interaction as evidenced by weak classification for content insulation between teacher's and learners' knowledge. However, with the exception of one inscription in Class B, which was mentioned earlier, the classification was weak with respect to content specialisation in all three classrooms. This means that the content in these classrooms was located only in the public domain although it had been recontextualised for the science classroom.

Two out of the three classes were strongly classified with respect to determining specific seating arrangements. This means that the teachers have made rational decisions about where learners should sit to improve classroom management and, as they saw it, to facilitate learning given the particular circumstances in their classrooms. The classroom (B) that was weakly classified in this respect seemed to be so for particular reasons as explained before.

Two out of the three classes (A and C) were generally strongly classified with respect to assigning definite roles for learners in the teaching and learning process. In these classes learners were assigned specific roles, which were seen by the teachers, as a mechanism for managing group work and ensuring development and learning for all individuals.

However the degree of content specialisation was very weakly classified and this is problematic for learner success. I will speculate how this has come about, and its implications for learner's success, in more detail in the next section.

6.5. Summary of analysis

This section shows how the analysis answers the questions posed at the beginning of this research project.

6.5.1. How and what are children learning in primary school science?

6.5.1.1.How are children learning in primary school science?

In general, the values for framing indicated that this is how teaching and learning takes place:

- There was an open form of communication between teachers and learners and between learners and learners (weak framing)
- The criteria for realization were made explicit (strong framing).
- A positive disposition was developed through the teacher communicating instructions, evaluating and giving specific feedback for success (strong framing)

The above mix of aspects, which define the pedagogy, were consistent with the results reported, by Morais and Perez (2001) which in turn supported the findings of Morais et al, (1993); Morais, Neves, et al, (2000); and Neves, (2001). Their findings suggested that such a mixed pedagogic practice containing high values for classification and framing for some aspects of the practice whilst having low values for classification and framing for certain other aspects could overcome the social background of disadvantaged learners even at the level of complex cognitive competences.

The how of learning and teaching, in the classrooms of my study, is structured in a similar way to that reported in the above-mentioned studies. Therefore we can assume it has similar advantages for the learners in the classrooms of the present study.

6.5.1.2. Why are some students not realising generalisable science concepts?

Whilst in a research project of this nature , we are offered only a glimpse of the classroom nevertheless this question can be answered by describing the nature of the discourse and therefore what was transmitted and acquired. In these three classrooms the selected content of the classroom discourse was located almost exclusively in public domain knowledge transmitted via a horizontal discourse, containing a weak grammar, although the regulative discourse emanates from the field of science. There were generally weak divisions between the content knowledge of different learning areas/fields and there were weak divisions between the content knowledge of learners and teachers. The content was transmitted mostly in the form of verbal dialogue on the part of the teacher and the use of structured worksheets, which were an extension of the teacher's verbal input and instructions. In the discourse the use of words and terms, which often came before the experiences, was foregrounded rather than explanations of science concepts.

The discourse took the form of instructions, key words and criteria, which were regulative and referred to descriptive (see information about how coal is formed. *Appendix 2: Plate 4f.p 173)* and procedural issues of form, rather than issues of conceptual understanding. This meant that managing the terms, names and language became the form of transmission, acquisition and realization. The discourse replicated and reproduced the procedural aspects of learning and did not lead to the explanatory, predictive and experimental aspects of the esoteric domain of science

6.5.1.3. Summary of the how and the what of the classroom practice

In these classrooms all the aspects of framing, in terms of a suitable mixed pedagogy as described by Morais and Perez (2001); Morais et al, (1993); Morais, Neves, et al, (2000); and Neves, (2001) are in place. Therefore these teachers have everything in place in terms of the *how* of teaching to deliver the curriculum effectively with the potential to overcome the social disadvantages experienced by learners. However the teachers are not yet delivering a curriculum that contains the *what* of teaching that fully serves the esoteric domain of science in terms of the basic literacy skills of science, being explanation and prediction, which in turn opens the possibility of approaching scientific activity by testing ideas against evidence. In the following discussion I will speculate as to why the pedagogy is so weakly classified with respect to the esoteric domain of science

6.6. Conclusion

In conclusion we can now describe the pedagogy in the classrooms studied. All three classrooms are characterised by a mixed pedagogy of a type similar to that described in the work of Morais and Perez (2001); Morais et al, (1993); Morais, Neves, et al, (2000); and Neves, (2001). The classroom discourse is a horizontal discourse, which is unspecialised with respect to science.

Chapter 7: Discussion

7. 1. Why is the pedagogy so weakly classified with respect to science?

7.1.1. Materials

Materials were one of the main ways in which the curriculum was transmitted and mediated in the classrooms in this study. The materials used were selected from ready-made sources by the teachers and in some cases also generated by the teacher from examples. All the materials appeared to be instructional, descriptive or procedural in form and required descriptive or procedural realization by the learners. None of the materials mediated explanations, predictions or hypotheses and none were required from the learners. The reason for this may be that the materials and the examples available to the teachers were limited in respect of deeper science investigations leading to explanations and descriptions. It may mean that writers assume the materials are merely a framework and that the teachers will mediate the necessary explanations for conceptual understanding. Or it may be that at primary school, science activity takes place at the level of providing experiences of natural phenomena and developing and practicing the process skills and their matching linguistic genres rather than providing and seeking explanations. A recent Internet search of materials produced in primary science programmes, undertaken by the Primary Science Programme in 2003, seems to confirm the latter perspective.

Teachers who have not received specialist training in science via PRESET or INSET will only choose material which is at the level of their own competence. Equally, teachers who design their own materials will also do so at the level of their own competence. The level of specialist science training given to primary school teachers is generally fleeting and scant (perhaps as little as a six week course over a four year PRESET period of study). Also, in many primary schools teachers frequently change grades and subject groupings from year to year. This has consequences for developing and sustaining competent science teachers. Moreover the emphasis in the training is to develop teachers who are generalists and are able to teach subjects across the curriculum in an integrated way and to nurture the development of the learner. This presents another problem for the teacher since she must know enough about a number of learning areas as well as have a good idea about how they are all connected and where the points of integration occur and how they can best be used to develop all aspects of the learner. For example, a teacher will need to know that the science process skills have matching linguistic processes in English, which may be different to the linguistic processes in an African language. She must also be aware that the science process skills also connect to and are supported by mathematical processes.

Worksheets of the type I have described and provided as examples seem to aid teachers in working with large and difficult classes. I would argue that, the type of worksheets that guide learners through a logical process should be complemented by others that help learners to construct their own logic. And also allow learners choose the forms of expression which they consider best suited to what they are trying to express. Similarly when the worksheets required no explanation by the learner, then no concepts were seen to be developed.

7.1.2. The de-emphasis of content

In the C2005 policy documents, no science conceptual framework was provided to guide programme designers, teachers and text book writers, although some examples of concepts appeared in the range statements. The range statements were also dropped from use early on in the WCED in-service teacher-training programme. This de-emphasis of content in the initial C2005 documents persists and is evident in the textbooks and learning programmes developed accordingly.

The lack of a conceptual framework as a starting point and the emphasis on the development of the process skills rather than on the employment of the process skills in developing the ability to plan and carry out investigations is an interpretation which may have been brought about by the wording of Learning Outcome 1 in the hybrid model of C2005 employed by the WCED which reads as follows:

The learner is able to: Use process skills to investigate phenomena related to the Natural Sciences.' (WCED, 2002)

The phrase 'use process skills' appearing at the beginning of the sentence seems to have placed emphasis on the process skills rather than the investigative aspects. WCED training documents were also used and sent out with lists of process skills deemed suitable for the different grades and these too seemed to foreground the process skills rather than the investigations leading to conceptual understanding. (WCED, 2002,p 34). However curricular revisions led to the publishing of the National Curriculum Statement (DOE, 2002). In this statement, Learning Outcome 1 (LO1) in the Natural Sciences places the emphasis back on investigations (in which explaining and predicting are necessary elements, although the assessment standards indicate that these are only developed in the higher grades of primary school and in the senior phase). Learning Outcome 2 (LO2) places more emphasis on conceptual development. In addition core knowledge and concepts are specified in the form of descriptive passages.

Whilst this begins to redress the current situation where teachers concentrate on skills and form rather than on developing conceptual understanding, explaining and predicting, the problem persists of teachers who are under-trained themselves in conceptual understanding and investigative skills. They may still choose materials that they are comfortable to teach from, but which do not necessarily help to mediate the deeper aspects of scientific understanding. In order to interpret the passages describing the content in the Core Knowledge and Contents (DOE, 2002), the teachers will still have to draw on their own deeper conceptual understanding if the outcomes are not to be interpreted and mediated in the most superficial and descriptive level, rather than explored in an explanatory and predictive way.

In the three classrooms studied, the teachers, either through their own limited specialist science understanding, or through the limitations of the curriculum itself as well as the limitations of the teacher training at the time and limitations in the materials, were inclined to implement programmes which were limited with respect to science concepts and understanding of the investigative process.

7.1.3. Integrated content

In C2005 the integrated and non-disciplinary vision of knowledge sought to establish a closer relation between education and training. This seems to have led, in the classrooms studied, to an emphasis on regarding success as the ability to master practical and process competence rather than developing theoretical frameworks and thought patterns for connecting concepts within a field and learning area. The integrated vision of knowledge also sought to connect school learning to everyday life, which seems to have had two rather contradictory results. The first is that it has required learning to be contextual, and related to learners' lives. This is thought to be motivating and has been identified by Morais et al (2001) as an important element in learner success. However it also has had the effect of limiting the pedagogic discourse to certain orientations to meaning bound by learners' situations, which is particularly limiting in the case of underprivileged learners. In this case we are not speaking about cultural deficits but the orientation to meaning that their socio-economic situation confers on them. This aspect, when included in a form of pedagogy that does not develop understanding and conceptual frameworks sufficiently, may account for the fact that learners do not achieve when tested independently of the classroom context. This is especially so when the test items require the application of knowledge and concepts to theoretical situations and formal representations, more typical of vertical discourse. This seems in part to account for Malcolm's et al. (2003) observations in classrooms where learners were highly engaged in activities yet were seemingly unable to transfer their learnings into the theoretical contexts presented in test items.

7.1.4. Formative assessment

Formative assessment is the type of assessment favoured in C2005. However in practice in these classrooms we see that although the assessment is ongoing, with the teacher evaluating regularly and giving feedback to learners in the classroom, the teacher is evaluating competence, that is, whether the learner has finished a particular task or not. By this I mean that the teacher has a set of criteria, which are mostly concerned with form, and she applies them with the national coding system. This coding system forces the teacher to decide whether the learner is able to do the task and with what level of competence, for example, 'The learner is able to do the task at a basic level.' (code 2) or 'The learner has met the criteria for this level and can move on to the next level.' (code 4) (WCED [redacted]02) These descriptors and their codes are describing levels of competence, which become achievement cut off points. The assessment coding system is not formative because it creates a cut-off point achieved rather than a position on a continuum of progress, with the continuum known to and understood by the learner.

The assessment criteria developed by the teachers are also almost exclusively about the form of the communication in a certain context rather than about understanding certain science concepts. It appears to be difficult for teachers to develop and apply assessment criteria that measure conceptual understanding. Firstly it is difficult to write generic assessment criteria, for example, for the concept evaporation. The generic would have to contain a description of evaporation in terms of energized water particles escaping the water surface and moving out into the atmosphere. But this concept can be applied to many different contexts and the explanation will be presented differently in different contexts. For example if the learner has to show understanding of the concept evaporation, by means of a drawing, in the context of the water cycle, different learners may show this concept in different ways and it is difficult for teachers to interpret what learners have drawn especially when learners display different competence in the skill of drawing. Equally, the learner might be required to write an explanation of what happens to a drop of water during evaporation. The ability to do this will not only depend on the learner's understanding of the concept, but also on their competence at manipulating language sufficiently well. How would the teacher be able to distinguish, from a conceptual understanding point of view, whether one learner is 'Able to do the task at a basic level.' And another is 'Able to, but not consistent, needs more practice. Only in one context.' These code descriptors point to competence at completing the entire task and do not point specifically to the learner having an underlying understanding of the relevant concepts.

It is against this background that we find that the lessons, in the three classrooms under study, contain tasks that are used for learning as well as for assessment. These tasks are complex and contain content as well as skills to be practiced and depend largely on competence in different modes of communication and in the use of language.

In the learning/assessment tasks that I saw in use, the teachers provided assessment criteria that required learner competence in communicating in a variety of modes. The different modes consisted of: writing, speaking, drawing, making models, and acting out *(See appendix 2: Plate 9a and 9b, pp181-182).* These modes corresponded roughly to the different learning styles described in the Theory of Multiple Intelligences put forward by Howard Gardner (Gardner, 1985) in which learners display different natural abilities. These can be developed in all learners by providing such opportunities to learn. The learning activities thus seek to provide such diverse opportunities to learn, as well as providing assessment tasks and criteria that assess these competencies.

In one classroom I studied (Class A), the teacher used generic descriptors, permanently displayed on the classroom walls, for each of the modes of communication. *(See Appendix 2: plates 9a and 9b, pp181-182)* These were then contextualised (usually by a process of negotiation with the learners) into a set of criteria for assessing tasks in different content areas. Competence in the mode of communication seemed to be required rather than understanding of the contents. There were no specific pointers in the criteria to measure conceptual understanding. This may have been because the tasks in the first place did not require learners to explain their understanding of concepts, but rather to describe phenomena and experiences.

In the RNCS (DOE, 2002), the assessment standards may allow different kinds of assessment depending on how they are used.) If they are read and applied in the sense that the competency described is confined to a particular year of study, they will again become cut-off points to measure competence, so that by the end of the grade the learners will either have achieved the desired assessment standard for that year or not. No credit will be given to those who are not yet performing at that standard and equally no recognition will be given for those performing beyond the standard for that grade. However if the assessment standards are understood and applied as a continuum, then the potential exists for teachers to record the learner's competence anywhere along the continuum over the first 9 levels in any given grade and this presents an opportunity for recognition and acknowledgement at any level, in any year. It also allows for the recognition of differences of levels within individual learners and between learners in the same year and similarly allows for tracking of the learner's levels of competence within a year. The assessment would then become formative in the sense that the learners' performance would always contain the potential to achieve at a further level, which is not bound by the expectations and level of the grade in which they find themselves. Using the assessment standards in this way would bring teachers closer to the development of formative practices. For this to happen it would also necessitate changing the national coding system so that the levels 1-4 corresponded with different levels on the continuum within a phase or over the nine years rather than on different levels of competence and achievement within a grade.

7.1.5. The role of the primary school teacher

I would like to make some points about the role of the primary school teacher and the imperatives that drive her practice. These imperatives may also account for the way that she teaches. When a primary school teacher takes on the task of teaching she is presented with class of learners who are immature individuals. They still have many years to go and much to learn and do before they become adolescents and finally adults. They are still in the process of acquiring their first language. They are still learning to trust their new caregivers. They are learning that the relationship between teacher and learner is similar but different to that which they enjoy with their families. They are also learning the ways of formal education, which may have a social structure very different to that experienced in their homes. Therefore I would argue that much of what the teacher does is to nurture the learner into these new ways, much as an adoptive family might nurture a learner new to their family. I would also argue that for the teacher, this is mostly a domestic task. We see that the domestic task of the teacher results in a horizontal discourse. This consists of a selection of content from many different fields as seen in the weak classification between fields, it results in a range of languages, which have to be managed, each having its own vocabulary and procedures.

7.1.6. Curricular coherence

The field of science consists of a matrix of previously universally accepted concepts connected by theories derived from and dependent on logical thought patterns, which are supported by evidence and which are open to critical scrutiny. This allows us to make predictions, which are then tested by investigation and explained in terms of the concepts and theories available, and occasionally new concepts and theories are formulated. In the classrooms studied, there were seen to be very few, if any, instances of explanation or prediction which would result in connecting learners to the matrix of scientific concepts or allow them to explore their own understandings and thus provide scientific coherence to the curriculum. So how is curricular coherence achieved in these classrooms?

In these primary science classrooms it seems that curricular coherence is achieved by the teacher using *narrative* as the principle mechanism, rather than connection to the conceptual and theoretical frameworks and thought processes of the field of science. As described in Class A, the teacher started a narrative in the learning area of choice, which had an internal logic, connected by a narrative. For example, when teaching about electricity the teacher constructed a narrative made up of a series of activities or experiences. Each activity was like a different chapter in the narrative in which the learners are exposed to different experiences linked to the previous experiences. The narrative started with an activity in which the learners explored the idea that we use energy for everything that we do. Then it went on to introduce the idea that we get energy from our food. This was followed by constructing food energy chains linking the energy from food to that of the sun as a source. This was followed by an exploration of the other sources of energy in our homes followed by linking sources of energy in the past with present day sources of electricity. Thereafter learners made simple electrical circuits and finally made their own electrical torch. The coherence of this learning programme was achieved by a context embedded narrative. At the same time the teacher had started a parallel narrative in Human and Social Sciences in which coal mining was explored and this in turn had links to the science narrative, coal being the source of electricity in the home.

It would seem that in the primary school, the science curriculum is embedded in a context close to that of the learners and furnishes the learners with experiences that only begin to allow them to name and describe their everyday experiences in terms of the science concepts of energy, energy sources, forms of energy, energy chains and circuits. The everyday experiences are re-described in terms of newly acquired scientific terminology, but not yet in terms of explanations or definitions of those concepts.

7.2. Theoretical limitations of this research project

Although the information uncovered in this research project was adequate to my interests, there were certain theoretical limitations. My experience of these classrooms was that there was a palpable bright-eyed productive ambience and enthusiasm in these classes during the observations. Thus far in this thesis, using Bernstein's (1996) theory there has been no place or means to describe this. This is because in my view theory is inadequate in this respect. Increasingly in education it seems that affective issues have assumed greater importance. This is in line with the expectations of the state that embraces a culture of human rights. Similarly, family expectations about treating children well in school have changed alongside social changes and the parent's right to have a say in education. Treating children well and taking care of the affective aspects may be crucial in developing the necessary attitudes for life long learning and in overcoming the socio economic disadvantages of children as they enter schooling. Whilst configurations of classification and framing are adequate for describing classroom actions and inscriptions, they cannot explain their value in terms of affective outcomes. Furthermore how would various configurations of classification and framing relate to the learning outcomes in the RNCS and are the assessment tasks presented in the appendices an adequate or sufficient measure of learning. Unfortunately these are some important aspects that this theory does not help to explain. It seems the theory cannot explain the affective aspects of these well-organised and happy classrooms. It also cannot explain the extent to which a positive ambience is necessary for productive learning. It also cannot explain what the outcomes of productive learning should be. It cannot explain how the relative emphasis on domestic and formal science can be brought together to effect in primary science classrooms.

7.3. Recommendations

Any science teaching has to pay attention to the descriptive, explanatory and predictive nature of science and the fact that science prepares learners for greater understanding of the material world. Also that the science teaching and learning must take place in a social context that is designed for success for all learners from whatever social class they may originate. Selecting models of science teaching and learning as well as learning support materials and teacher in-service support that incorporate these aspects seems to be the key to a successful enterprise. Therefore my recommendations are as follows:

- Teachers should receive pre-service training and in-service support to develop their own knowledge about the nature of science and its contents and concepts. In order to do this, teachers will need support in developing their own investigative competencies (which develop and depend on prediction and explanation). In addition they should receive assistance to perfect their explanations of concepts.
- Learners must be given many and varied opportunities to interact with equipment, materials and the natural and man-made world
- Designed teaching sequences should incorporate explicit instances in which the teacher will have to name and explain concepts, as well as opportunities for the learners also to describe, predict and explain. Teaching sequences should incorporate opportunities for learners to carry out manageable investigations. Opportunities to predict and explain should also be incorporated into learner assessment tasks.
- Learner support materials should incorporate explicit opportunities for learners to describe, predict, investigate and explain. The materials must name the concepts being developed and include explanations of these concepts where necessary.

7.4. Proposals for future work

There is no doubt that in times of curriculum change it becomes necessary to study what happens inside classrooms. Classrooms have become very complex places and teaching and learning a complex process. In classrooms where learners are engaged in group work and where they have to interact with equipment and material, there arise many levels of social organisation and ways of learning. In some cases learners may be learning more from each other and from the materials than they learn through interaction with the teacher. Therefore I propose the following suggestions for future work:

- Detailed studies of classroom social organisation to devise more effective ways to organise classrooms for learning, so that social as well as personal learning takes place.

- Detailed studies of student interactions when working in groups to understand how the social dynamics work and to describe the kind of learning that takes place, including detailed studies of student talk in groups. Do learners explain to each other and what concepts and language do they use? Do they develop science concepts during group work?
- Studies in the development of different kinds of teaching sequences and their effectiveness.
- Longitudinal studies that map the development of learners over time.
- Studies of INSET programmes and their effectiveness.
- Studies of different ways to assess learner progress.
- Studies of different teacher and learner support material designed to improve learning.

A strong recommendation is that effective ways are devised to inform and assist teachers and education practitioners of research developments in their field and to assist them to implement strategies, which are *based on* researched information.

Appendices

Appendix 1 Letter of permission

Telefoon
Telephone 425 7400 ext 2238
IFoni
Faks
Fax 425 7445
IFeksi
Verwysing
Reference 2002 0626-0023
ISalathiso

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

A1: 1

Ms R Thomas
9 Budock Street
CLAREMONT

Dear Madam

Re: A COMPARATIVE ANALYSIS OF SCIENCE INSCRIPTIONS IN THREE PRIMARY SCHOOL CLASSROOMS.

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

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and learning sites should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Videos and interviews and completion of questionnaires are allowed as long as these do not impinge on educators' programmes.
5. The investigation is to be conducted from 24 July 2002 to 25 September 2002.
6. Should you wish to extend the period of your survey at the schools, please contact F Wessels at the contact numbers above.
7. The investigation is not to be conducted during the fourth school term.
8. A photocopy of this letter is submitted to the principal of each school where the intended research is to be conducted.
9. Your research will be limited to the following primary schools: Blackheath; Imperial and Bridgeville.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:
    The Director: Research
    Western Cape Education Department
    Private Bag 9114
    CAPE TOWN
    8000

We wish you success in your research.
Kind regards.

pp Wessels
ACTING HEAD: EDUCATION
DATE: 26/02/2002

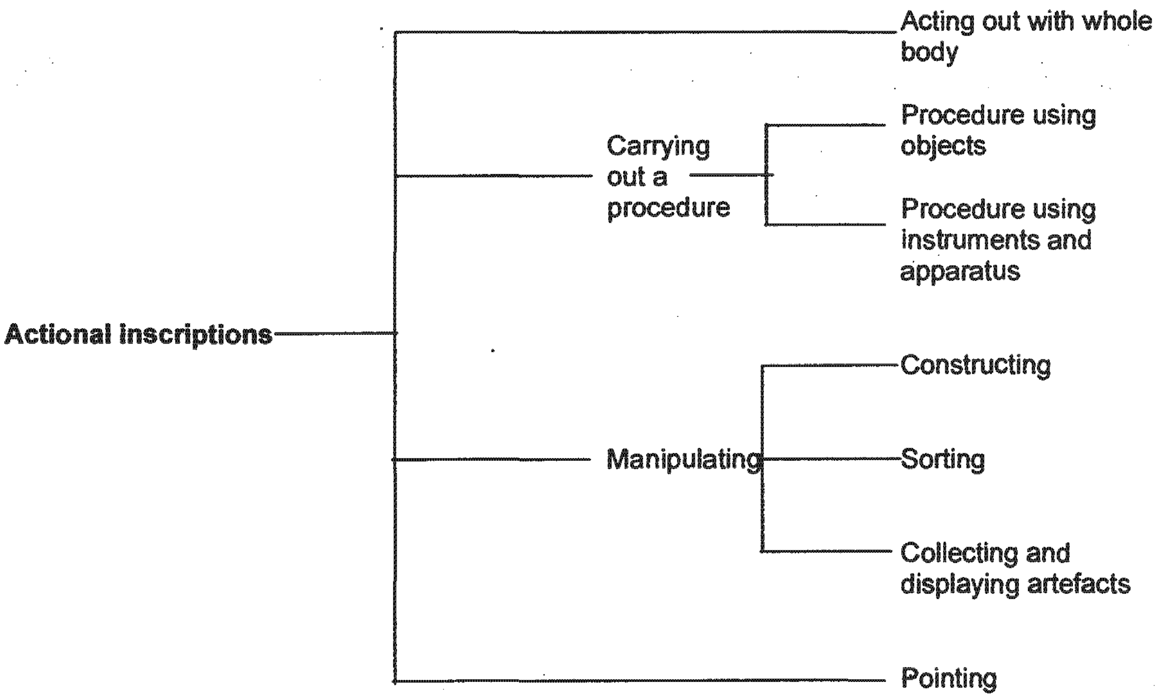


Figure A 1: 2 Systemic network illustrating actional inscriptions

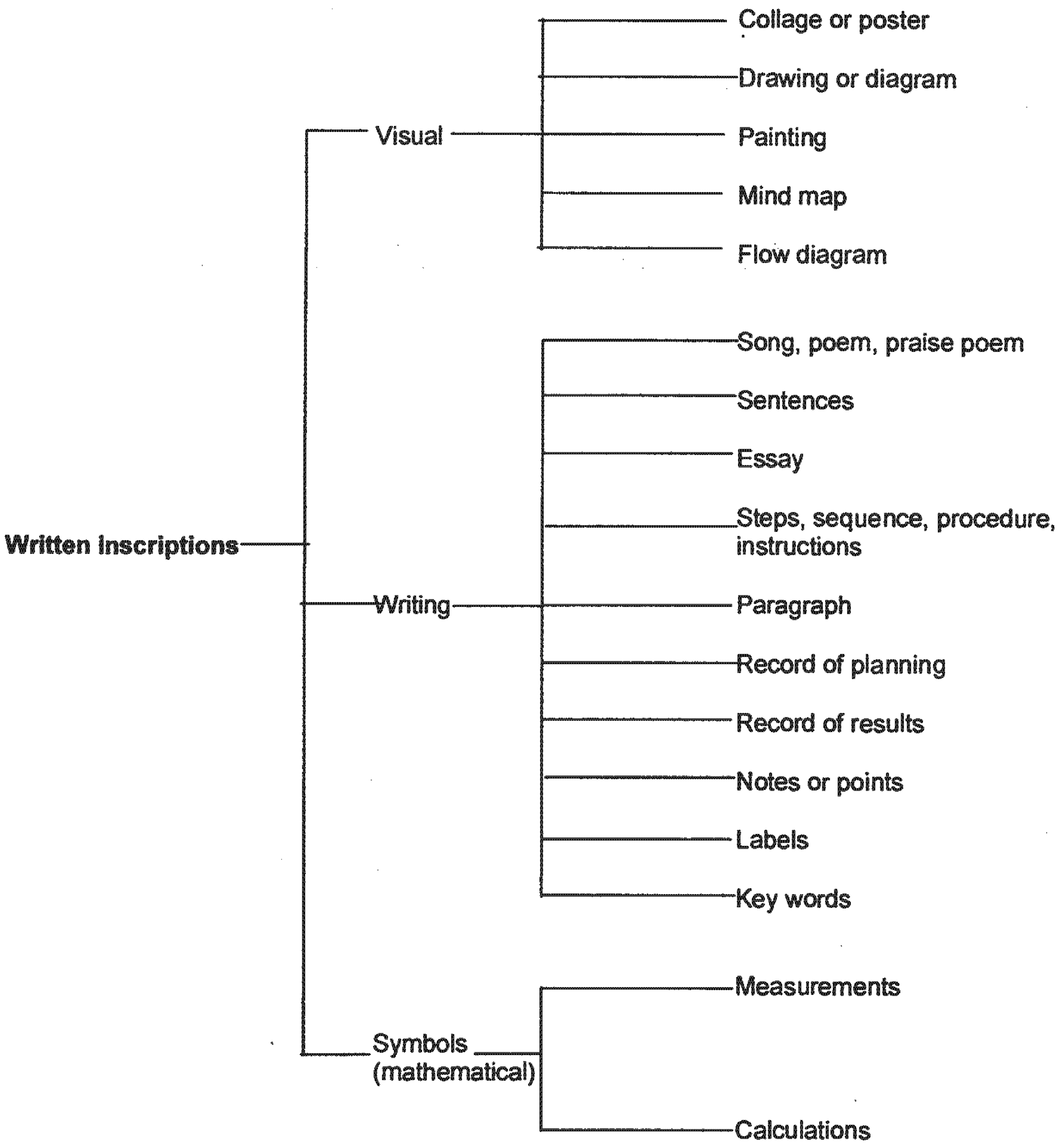


Figure A1: 3 Systemic network illustrating written inscriptions

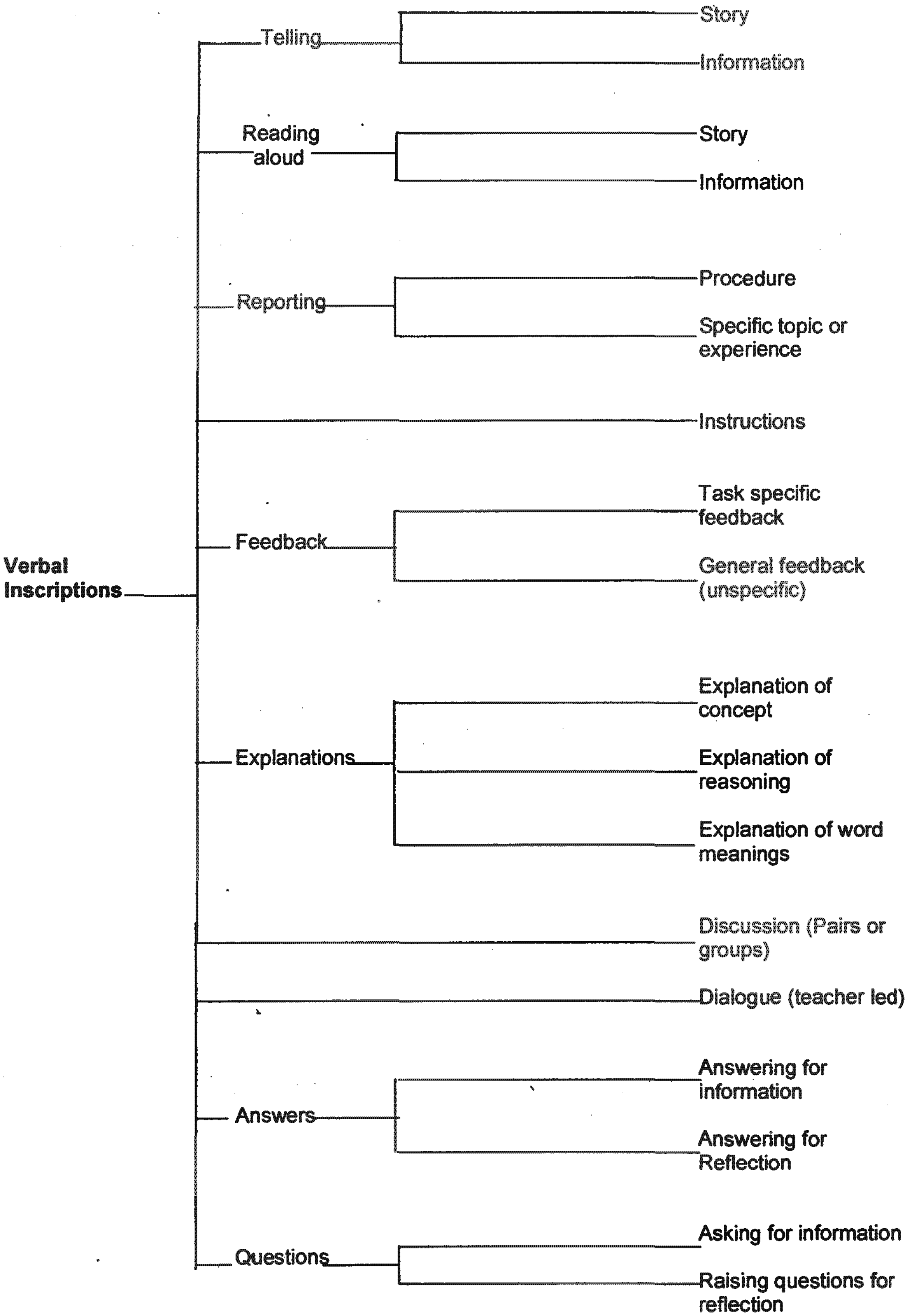


Figure A1: 4 Systemic network illustrating verbal inscriptions

A1: 5 Timelines from classroom observations

Table: Class A: Lesson 1 4/09/02	***The Teacher's communication via verbal, written and actional inscriptions***			
Time	Function	Verbal	Written	Actional
8.55	**Introduction to lesson on energy** **General instructions**	**Question-'What are we getting from our sandwiches?'** **Instructions-'Put the wires in front of you.'**		**Hands out sandwiches**
9.00	**Feed back about previous days work** **Introduction, contd.**	**General feedback to learners-'I'm surprised at the detail.........'** **Questions-'What did you have for breakfast?' 'Energy?' 'What's inside the plastic (wires)?'** **Key word- 'Copper"**		
9.05	**Preparation of equipment and materials for the task**	**Explains how to strip wires** **Instructs learners to pay attention** **Instructs learners to find the page of pictures of energy sources** **Key words-'Source of energy', 'coal', 'wood.'**	**Pictures of energy sources**	**Using tools to cut and strip wires**
9.10	**Orientation around topic and stimulus for discussion**	**Tells story of sitting around a coal fire in winter** **Class discussion about 'old' and 'new' sources of energy**	**Pictures of energy use 'Then and now'**	
9.15	**Orientation around equipment to be used**	**Question-another name for batteries? 'cell', 'Why does he say a watch? What type of cell?'** **Instruction-'Take out a battery and lets describe it'**	**Mind map-uses of batteries**	
9.20	**Describing batteries and giving children feedback**	**Question-'What can anyone tell me about this battery?' Do you have this positive and negative?'** **Key words-'cylindrical', '1.5V', 'flat side called a base', 'wrong side/right side'.** **Feedback-' I know what you are trying**	**Picture of a cell on the overhead projector**	**Holds up battery and points to parts of battery as learners describe.** **Points to positive and negative ends of the battery**

		to say.'		
9.25	Describing light bulbs Orientation to task	Question- 'Have you ever thought who invented an overhead projector'- go and find out. Questions. Do you think there's a + and – in the light bulb? You are going to find out. 'What will happen if I connect this light bulb to this battery/	Picture of light bulb	Puts picture of light bulb on overhead projector
9.30	Explaining how to label Hypothesizing Instructions about task and sharing equipment	Explains how to label 'We move out from the parts to the label.' Key words- 'metal casing', 'hypothesis' Questions-'Why will it work? Why will it not work?' Instructions-'You must make the light bulb light.' "One cell, two wires, three people per group.' Key words-'This is fragile.' (the light bulb)	Picture of a light bulb	Points to part and then moves pen out to the label Hands out bulbs
9. 35	Starting the task	Instructions-'You may start.' Individual feedback at groups in form of questions Class feedback-'can I give you a clue?' 'I know you can do it with one wire, do it with two.'		
9.40	Information to help the task	Information- 'There are two sections to the light bulb.' Feedback- 'Excellent.'		
9.45	Instructions to finish	Instructions-' Hands together, close eyes, put things in the box.'		

Permanent inscriptions

In this classroom the teacher has lists of common verbs and nouns on permanent display on the classroom walls. She also has a permanent display of generic assessment criteria for five forms of communication, i.e. writing, speaking, making models, drawing and acting out.

Table: Class A: Lesson 1 4/09/02
The Learners communication via verbal, written and actional inscriptions

Time	Function	Verbal	Written	Actional
8.55	**Introduction to lesson on energy sources**	**Answering-'energy'**		**Eating sandwiches**
9.00	**Listening to teacher's feedback and introduction**			
9.05	**Preparing apparatus**			**Passing wires to teacher for stripping** **Learners finding plastic sleeve with drawing, and fold arms when ready**
9.10	**Listening to teachers story**			
9.15	**Question and answer session with teacher (whole class)**	**Answering teacher's questions- 'coal', 'wood'.**		
9.20	**Describing Batteries** **Proffering information**	**Answering questions describing battery** **Learner describes spring in torch which touches the cell.**		
9.25	**Proffering information**	**Learner describing how to insert the battery the right way**		
9.30	**Listening to teachers explanations**			
9. 35	**Doing the task**			**Using apparatus to make electric circuits** **Hand gesture- 'Coaches' put their hands up to get teacher's attention.**
9.40	**Continue with task**	**Feedback fro m learners when task is completed-'Yes Miss!'**		**Using apparatus to make electric circuits**
9.45	**End of lesson**			**Learners pack away and fold arms**

Table: Class A: Lesson 2 5/09/02
The Teacher's communication via verbal, written and actional inscriptions

Time	Function	Verbal	Written	Actional
9.00	Introduction to lesson about lighting a light bulb	Question-'What did we do yesterday?' Describes the circuit Key words-'circuit', 'fragile' (light bulb) Instruction to draw the circuit	Provides a task card with instructions and a space to draw	Points to size of page for drawing
9.05	Instructions about doing drawing task	Question-'What are criteria?' Says learners must keep looking at criteria when doing the task. Instructions about keeping folders in order and spelling 'No incorrect spelling-words on the board'.	Writes criteria and list of key words on chalkboard	Points to criteria on chalkboard
9.10	Monitoring groups	Individual feedback-'Nice.'		
9.15	Monitoring groups	Question-'finished drawing/'	Adds mark allocation to criteria	
9.20	Reminder to groups	Instructions- 'Write the criteria and a line for the marks.'(on the page where learners do the drawing.) 'Ask yourself," what do I still need to complete this drawing?" ' Information about the mark allocation Explanation about why a circuit 'Another 10 minutes'		Pointing to mark allocations
9.25	Clarifying meanings of criteria	Explains what is meant by 'clear lines' (one of the criteria for drawing) and gives feedback to individual learners		
9.30	Adding more words for labels Feedback Checking the time	Gives information about adding new labels 'How many labels do you have/' Question-'Timekeepers?'	Adds 'glass' and 'cell' to list of key words for labels	

9. 35	**Instructions**	**Instruction- 'Start with the writing now.'**		**Takes learner to the chalkboard and points out the word 'cell'.**
9.40	**Instructions and reminders** **Visualization** **Discussion**	**Question-'Do you all have labels?' 'What have you done?"** **Instruction-'Fold your arms and all eyes on the board. 'Pretend you are writing to someone who is blind, close your eyes and visualize in your mind.'** **Question-'What did you do?'**		
9.45	**Reminder about writing a report**	**Instruction- 'sentence must tell me its already happened.'** **(Referring to past tense for report writing)**	**Provides a writing frame to assist learners to write their report**	
9.50	**Summary**	**Reminds learners what they have done**		

Table: Class A: Lesson 2 5/09/02 *The Learners communication via verbal, written and actional inscriptions*				
Time	Function	Verbal	Written	Actional
9.00	**Introduction to lesson about lighting a light bulb**	**Answer questions about yesterday's work**		
9.05	**Listening to instructions about task**			
9.10	**Doing the task**		**Learners write criteria and key words onto task card** **Drawings- diagrams of circuits**	
9.15	**Finishing task**		**Drawings -diagrams of circuits**	**Hand gesture- Hands up when task is finished**
9.20	**Listening to reminders and instructions**		**Drawings- diagrams of circuits**	
9.25	**Listening to clarification of criteria and feedback**		**Drawings- diagrams of circuits**	
9.30	**Listening to feedback**		**Drawings- diagrams of circuits**	
9. 35	**Instructions for writing task**		**Writing report (using writing frame)**	**Whole body-learner walks to chalkboard with teacher**
9.40	**Doing writing task** **Discussion**	**Answering questions-words and explanations (in past tense)**	**Writing report**	
9.45	**Listening to teacher explaining why past tense must be used**			
9.50	**Listening to teacher summarize**			

Table: Class B: lesson 1 14/08/03
The teacher's communication via verbal, written and actional inscriptions.

Time	Meaning Function	Verbal	**Written**	Actional
10.50	**Introduction to lesson on electricity**	**Key words-energy chains - Forms of energy**	Writes key word- 'energy' on chalkboard	
10.55	**Introducing key words and lesson focus**	**Asks questions –sources of electricity**	Writes key word- 'electrical energy' on chalkboard	
11.00	**Orientation and reminder around the topic**	**Asks questions-appliances**	Pictures about appliances in the home	**Hands out pictures for discussion about appliances**
11.05	**Instructions for discussion task Monitoring progress of group discussion**	**Gives instructions Asks specific questions at groups**	Writes key words on board	
11.10	**Stimulus for further discussion about appliances 'then' and 'now'**	**Story about 'olden days' Instruction to 'imagine' what it would be like to live without electricity as in the 'olden days'. No street lights etc.,**		
11.15	**Providing information and reminder of context for study of electricity**	**Information about electricity in the home, Answers learners questions Information- refers back to 'Mr. Hendricks's lesson (other science teacher)**	Writes key –word- static electricity	
11.20	**Orientation around topic 'static electricity'**	**Instructions about rubbing rulers and attracting hair Story about the teachers cat and how the TV attracts its whiskers Questions-'Where have you experienced statics?'**		

11.25	**Instructions about task**	**Gives instructions about:** • **Procedure to be followed** • **What to report 'Tell me what happens'** • **How to complete the worksheet** • **Time** • **How many sentences to write**		
11.30	**Introducing the worksheet**	**Reads aloud from worksheet** **Explains concept of static electricity**	Writes key words for completing Worksheet 1on chalkboard	**Points to places to fill in on worksheet**
11.35	**Helping learners with writing**	**Gives information about the connecting words to use when writing instructions (first, next, then, etc)**		
11.40	**Feedback to groups**	**Gives specific feedback to groups and says 'write in isiXhosa if you want to.' Information about continuing tomorrow** **Feedback to whole class, Gives an example of a completed piece of writing**		
11.45	**Final instructions**	**Give instructions for homework**	Writes criteria about the form feedback should take	

Teacher explaining concept of static electricity:
T 'I want you to tell me what happens when something gets charged. First thing you must do?'
L 'Rub it.'
T 'Yes rub it. Second thing you must do- put it on pieces of paper- then pick it up. What happens? Electrical charges... because of friction...electricity moves through here and then attracts the other object.'

Table: Class B: Lesson 1 14/08/03 *The learner's communication via verbal, written and actional inscriptions*				
Time	Meaning Function	Verbal	Written	Actional
10.50	Practising new terminology about forms and sources of energy	Say key word- forms of energy, energy chains		
10.55	Explaining what learners know	Explain understanding of concepts –sources of energy		
11.00	Responding to teacher's questions Doing the task	Answer questions about appliances Group discussions about appliances 'then' and 'now' using pictures		
11.05	Responding to teachers questions at groups	Answer teachers questions about the discussion		
11.10	Initiating questions	Asking questions about energy and appliances (mostly about TV and Radio)		
11.15	Proffering information	Informing class about low energy light bulbs using less electricity and other aspects of electricity		
11.20	Doing the task (generating static electricity			Using apparatus-rubbing rulers with cloths and picking up small pieces of paper
11.25	Proffering information	Informing about experiences with electricity		
11.30	Completing the task		Write instructions on worksheet (sentences and key words)	
11.35	Completing the task		Write instructions on worksheet (sentences and key words)	

11.40	**Reporting to class on completing the task**	**Report back on specific topics**		**Clap hands for correct answers**
11.45	**Judgment of task completion based on criteria**	**Class gives feedback to groups based on criteria written by teacher**		

Table: Class B: Lesson 2 20/08/02
The teacher's communication via verbal, written and actional inscriptions

Time	Meaning Function	Verbal	Written	Actional
9.15	**Introduction to lesson on coal**	**Asks questions about Coal, uses of coal Tells that 'we will do this later' (coal and electricity) Instructions, reads questions for discussion (How is coal formed?)**	Key words-writes 'coal', 'hydro-electricity' and 'uranium' on chalkboard	**Hands out worksheets about coal to latecomers**
9.20	**Instructions for discussion** **Monitoring group discussion**	**Instructions-'I want to know what you think', 'take turns, don't dominate Gives specific feedback at each group**		
9.25	**Monitoring group discussion**	**Answers questions at groups**		
9.30	**Monitoring group discussion**	**Feedback-'I have two groups who have finished'**		**Head gesture- teacher tilting head to listen to learners talking in discussions**
9.35	**Finding out what was discussed**	**Asking question to clarify 'What did you discuss?'**		
9.40	**Providing information**	**Reads information from text and worksheet about ' How coal is made in the Earth '.**	Text; 'How coal is made in the Earth'.	
9.45	**Referring to the text**	**Question 'Which picture matches paragraph 2' 'What are the key words here?'**	Writes key words on chalkboard- 'pressure, squeezed, peat'	
9.50	**Meanings of words**	**Asks questions about the meanings of words in text and explains them' Peat is...'**	Writes key words on chalkboard-'peat, absorb, soft'	
9.55	**Meanings of words**	**Asks questions about the meanings of words in text**		

		and explains them		
10.00	**Instructions**	**Tells learners to 'Match the paragraphs with the pictures.'**	Pictures and text about how coal is formed (cut and jumbled)	
10.05	**Feedback about the matching task**	**Asks 'Do you all agree?' (with the way the pictures and text have been matched)**	Pictures and text about how coal is formed	**Displays the matched pictures and text on chalkboard**
10.10	**Feedback about the matching task**	**Reads aloud paragraph 3 of text**	Pictures and text about how coal is formed	
10.15	**Drawing the lesson together**	**Explains the formation of fuels. Asks learners to explain**		
10.20	**Drawing the lesson together**	**Explains the formation of fuels**		
10.25	**Learner explanations**			
10.30	**Learner explanations**			
10.35	**Learner explanations**			
10.40	**Getting learners to think about their own learning**	**Asks question 'How does this answer compare with yours?'**		

Table: Class B: Lesson 2 20/08/02The learner's communication via verbal, written and actional inscriptions				
Time	**Function**	**Verbal**	Written	**Actional**
9.15	**Introduction to lesson on coal**	**Answer questions about coal and the use of coal**		
9.20	**Group discussion**	**Discuss questions on worksheets**		
9.25	**Group discussion**	**Learners at two groups ask teacher questions**		
9.30	**Groups hypothesizing**	**Hypothesize about where coal comes from- 'volcanoes', buried and petrified wood, from 'burning wood'.**	Take notes about discussion (1learner per group writes)	
9.35	**Results of discussion**	**Answer questions from teacher by calling out**		
9.40	**Reading and understanding text**	**Answer teachers questions about text One learner reads paragraph 1 out loud**	Underline key words in text about how coal is formed	
9.45	**Reading and understanding text**		Underline key words in text about how coal is formed	
9.50	**Reading and understanding text**	**All learners read paragraph 1 aloud**	Text about how coal is formed	**Point to map of Sasolburg**
9.55	**Group feedback**	**Selected groups tell which picture matches this paragraph and co- tell the contents of the text**	Text about how coal is formed	**Point to Western Cape on map Matching pictures and texts**
10.00	**Reading and understanding text**	**One learner reads paragraph 2 aloud All learners read paragraph 2**	Text about how coal is formed	**Matching pictures and texts**

10.05	**Reading and understanding text**	**One learner reads paragraph 3 aloud One learner explains his reasoning when asked by teacher**	Text about how coal is formed	**Matching pictures and texts**
1010	**Reading and understanding text**	**All learners and teacher read paragraph 3 aloud All read paragraph 4**	Text about how coal is formed	**Matching pictures and texts**
10.15	**Listening to teacher explanations**			
10.20	**Listening to teacher explanations**			
10.25	**Learner explanations**	**Selected learners explain how fuels are formed**		
10.30	**Learner explanations**	**Selected learners explain how fuels are formed**		
10.35	**Learner explanations**	**Selected learners explain how fuels are formed**		
10.40	**Thinking about learning**			

Table: Class C: lesson 1:7/08/0 The teacher's communication via verbal, written and actional inscriptions.				
Time	Function	Verbal	**Written**	Actional
10.55	**Orientation to forms of energy**	**Questions about forms of energy**	**Concept map**	**Hand gesture-holds up battery**
11.00	**Meanings of key words** **Procedure**	**Explains meaning of key words**	**Key words –sources of energy** **Writes steps on board**	**-makes trumpet with hands to show sound** **Hands out equipment and task cards**
11.05	**Procedure**	**Instruction-'time up'** **Tape wire to base of battery**	**Task cards on tables at each group**	
11.10	**Feedback**	**Specific feedback to groups**	**Task cards**	**Pointing to apparatus and task card**
11.15	**Instructions** **Feedback**	**'time up'** **'Label it '-to group**	**Task cards**	
11.20	**Instructions** **Feedback**	**'two more minutes'** **'label it'-to group**	**Task cards**	**Pointing to specific things on worksheets at groups**
11.25	**Instructions**	**'Even if not finished-time up'**	**Task cards**	

11.30	**Instructions to prepare for learners feedback and observations** **Questions and feedback about their observations**	**Instructions about the feedback- 'Come and paste your picture on the board'** **'Fold your arms and face the front'** **'Why do you think it doesn't light up?'**	**Notes-answers to questions on worksheets writes on chalkboard**	**Uses apparatus to demonstrate the circuit from the front**
11.35	**Explanations and teacher feedback to learners** **New instructions**	**Explains that connections to side versus to bottom of light bulb are different** **Feedback to the whole class about their drawings** **Instructions to put the date on page**		**Pointing to drawings of circuits** **Hand gestures – draws capital letters with her fingers** **Hands out worksheets**
11.40	**Introduction to individual learner worksheet**	**Reads aloud questions on worksheet.**	**Work sheet with questions about making the circuit**	

Table: Class C: Lesson1 7/08/02The learner's communication via verbal, written and actional inscriptions				
Time	Function	Verbal	Written	Actional
10.55	Orientation to forms of energy	Answering-forms of energy		
11.00	Preparing to do practical activity			Runners hand out equipment, bulbs, wires, etc,
11.05	Learners doing activity	Talking in groups-discussing activity		Using apparatus to make electric circuits
11.10	Learners doing activity	Talking in groups-discussing activity	Labels on diagrams	Using apparatus
11.15	Learners doing activity	Talking in groups-discussing activity	Group drawing electrical circuit Writing on task cards (words, phrases, sentences)	Using apparatus
11.20	Learners feedback and report to teacher and class	Individual feedback to teacher-'There Missi' (has made bulb light up) One learner explains to whole class how they made a circuit	Writing on task cards (words, phrases, sentences)	Displaying drawings on the board (from each group) with prestick
11.25	Learners feedback and report to teacher and class	Learner from second group explains to whole class how they made a circuit	Writing on worksheets (words, phrases, sentences)	
11.30	Learners feedback and report to teacher and class	Selected learners from different groups give answers to questions on worksheets	Writing on worksheets (words, phrases, sentences)	
11.35	Learners completing group worksheets		Writing on worksheets (words, phrases, sentences)	Handing out individual worksheets
11.40	Learners completing individual worksheets		Writing and drawing on individual worksheets (words, phrases, sentences)	

Table: Class C: Lesson 2 8/08/02
The teacher's communication via verbal, written and actional inscriptions

Time	Function	Verbal	Written	Actional
10.55	Introducing lesson on static electricity	Explains meaning of the word 'Static electricity' Explains the concept and gives example of hair standing up	Key word-'static electricity'	Hand gesture-shows how hair stands up
11.00	Instructions	'Break up bits of paper'		Using apparatus- demonstrates how to break up the paper
11.05	Questioning about learners observations	'What happened?'		
11.10	Explaining concepts and words and giving instructions for task	Explaining the concept 'static electricity' Reciting the words with learners Instructing to draw what happens	Labels on board- 'ruler, toilet paper'	Pointing to place on worksheet to draw
11.15	Instructions to get learners to draw and write	Instructing –'One more minute, then draw.'	Sentences-writes two sentences on chalk board with some words missing and indicates how many	Pointing to drawings displayed on board and then to questions
11.20	Instructions about time and feedback to learners	Instruction-'must learn to work to time" Gives specific feedback to each group		
11.25	Information about self-assessment worksheets	Explains more about static electricity and gives information about self-assessment. Reads aloud the information and questions from the worksheet for self assessment		Whole body –demonstrates how some learners rubbed their jerseys and put their shoulders to pieces of paper

Table: Class C: Lesson 2 8/08/02
The learners communication via verbal, written and actional inscriptions

Time	Function	Verbal	Written	Actional
10.55	**Listening to teachers introduction (static electricity)**			
11.00	**Instructions for the task about static electricity** **Doing the task**	**Readers read aloud the instructions for the task at each group** **Discussion at the groups about the process of experimentation**		**Use apparatus – rubbing plastic rulers and picking up pieces of paper**
11.05	**Answering questions about the task**	**Learners answer questions about what happened in the task and report their findings** **Recite words with teacher e.g. 'Static electricity'**		**Use apparatus-e.g. Learner rubs scarf against her hair and it stands up**
11.10	**Completing the task**	**Answer questions about what to write**	**Group drawing on task card**	**Use apparatus**
11.15	**Completing the task**	**Discussion about writing**	**Individual writing on worksheets (words, phrases and sentences)**	**Use apparatus**
11.20	**Preparation for displaying group worksheets**			**Displaying group worksheets and drawing on board**
11.25	**Doing self assessment**		**Individual writing on self assessment worksheet (words, phrases and sentences)**	

A1: 6 Questionnaire for Teacher Interviews

1. *Explain to me why you have arranged your classroom as you have? Tell me about the learners' seating arrangement.*

   The purpose of these questions was to find out whether the teacher or the learners determined the seating arrangements and if there was any reason or organising principle behind that. I wanted to find out if the observed seating arrangement was fixed, or was subject to change over time, or whether seating was arranged differently for different purposes. I wanted to find out if there was a pedagogic purpose to the seating arrangements, for example, to facilitate group explorations of the content; or for regulative reasons, for example, as an aid to keep discipline; or the grouping of learners according to ability levels

2. *How do you decide what you are going to teach this week? Tell me how you decide what comes before this lesson and what comes after this lesson.*

   The purpose of these questions was to gain insight into whether the teacher and/or the learners were involved in the selection of the order and/or content of the lessons. I wanted to find out whether the teacher might select from a teaching sequence predetermined by a textbook or ready-made learning programme. I hoped to find out whether there were underlying principles to the selection or sequence, such as a sequenced development of concepts or skills.

3. *I see that learners are doing different/the same tasks. How do you assign tasks to learners? Do they have certain roles? How do you organize this? How do they know what they have to do?*

   The purpose of these questions was to establish whether there were predetermined roles assigned to learners amongst themselves or alternatively assigned by the teacher, or whether learners assumed roles for themselves within a group when necessary. I wanted to find out if distinct learner roles resulted in different learners performing different functions or tasks, for example, runner, or reader, or writer. (These are roles, which originate from co-operative learning strategies, in which learners are given specific roles to perform when working co-operatively). For example the runner would have responsibility for fetching and carrying apparatus and papers from place to place, when required, in the classroom. Similarly the reader and writer would be assigned to carry out the reading and writing task respectively for the groups when required. I also wanted to find out if assigned roles were changed around and if so, in a systematic way.

4. *Did you notice any interesting or unexpected things in this lesson? Tell me about them.*

   The purpose of this question was to find out what the teacher noticed as significant in the lesson. This would provide insight into what the teacher values as significant in the lesson, whether she notices when learners do unexpected things and how s/he responds to it.

5. *Do you expect all the learners to be able to do the tasks you give them? Tell me how you make sure that learners can complete the tasks you have given them?*

   The purpose of these questions was to understand how the teacher evaluates the learners work and the kind of expectations that the teacher has of learners and their ability to complete their tasks satisfactorily. The second questions would provide insight into the responsibility a teacher might feel to find strategies and measures to assist learners to realise her expectations.

6. *When you are teaching science do you take into account the context (background, experience and home circumstances) of the learners and their own knowledge? Tell me about this.*

   These questions would give me insight into the selection of content, and whether the teacher values the learners' knowledge and contexts in her selection of content and during classroom discussion.

7. *Are you a class teacher (teach all subjects to the same class) or a subject teacher? Do you plan your whole curriculum across all the subjects? If so, tell me how this is done.*

   The purpose of these questions was to find out whether the teacher integrates content across the different learning areas and if so how this is done.

8. *How do you assess learners' work? Do you have criteria for assessing their work? If so where do these come from? Do the learners know what the criteria are?*

   These questions would throw light on what criteria the teacher used to assess learners' work. I wanted to find out whether the teacher uses criteria from the textbook or learning programme or whether she generates them with the involvement of learners. I wanted to know whether they are made explicit to the learners in any way.

Appendix 2: Presentation of data

The data takes the form of text extracts from the classroom interactions that are coded with respect to their degree of strength of framing and classification. The artefacts consist of photocopies of the learners' work, photographs of artefacts from the chalkboard and walls of the classroom, and seating plans

Note: I have not supplied full transcripts of the interactions in the classroom and teachers' interviews, but instead have taken exhaustive extracts from the empirical instances to illustrate the theoretical variations within framing and classification. However copies of the video and audio records are available on request. I have also supplied evidence in the form of photocopies of the learners' work, photographs of artefacts from the chalkboard and walls of the classroom, and seating plans

The reading conventions for the extracts from classroom interactions and the teacher interviews are as follows:
T indicates teachers' voice
L indicates learners' voice/s
R indicates researchers voice.
Planning refers to the structural level of classroom practice
Enactment refers to the level of events in the classroom

1. Presentation of data for framing

<u>1.1.1. Selection of content</u>

Instructional context
Discursive rules-selection of content

Class A (planning level)
Here the teacher controls what is to be selected for teaching and learning. She explains *how* she goes about selecting the contents that 'fit' into her narrative at the planning stage. She explains that she selects the content that will fit with her broader narrative that involves integrating sections of content from across a number of learning areas.

F++

T. 'I would take science, or maths, HSS (Human and Social Sciences) and I would introduce the EMS (Economic and Management Sciences). So why are we doing the EMS? What has mining got to do with the EMS?

R. " So are you saying that you consciously make the links between the subjects that you are integrating?'

T. "All the time. I try to do it in a narrative form."

R. "OK"

T. "Where I'll give them a story line. If for instance, lets say mining is the first thing in HSS. But at that stage I would only introduce a learning area when it fits into that lesson."

R. "If its part of the narrative?"

(Extract from teacher interview 5/09/02)

Class A (enactment)

Here the teacher explains *how* she indicates, as reminders to the children, the selected contents for the lesson, which are to be used in a particular task by writing the key words on the chalkboard

F++

T. " The key words are there to assist the children with spelling, and seeing the word constantly will make meaning to them eventually. That...when we are doing anything practically, I would put the word on the board. If, for instance, this one, it says make a windmill with your arms. That was...first they had to read this, then they had to show me the actions. So which this means that they heard the word, they had to do it first, then I put it on the board, and then they had to read it. So with this they associated the action with the words, they need to understand that."

(Extract taken from teacher interview 05/09/02)

Also see list of key words for class A. Appendix 2: plate 1, p164

Class B (planning level)

The teacher indicates the content for the day, which she has selected, by means of a verbal statement.

F++

T. ' That is what we are going to look at today, electricity. We know lots of kinds of energy but this one we are looking at today is electricity, and electricity has something that has the ability to make something work.'

(Extract taken from lesson1, 14/08/02, 10.50am)

And

Class B (enactment)

Here the teacher explains how she communicates the contents she has selected, and which she expects students to use in completing their tasks, by means of key words written on the chalkboard.

F++

T. 'They must write in their own words, maybe a little paragraph or essay. They must go back to the key words. They must repeat this in their own words which would be my indication that they understand this.'

(Extract taken from teacher interview 20/08/02)
Also see list of key words. Appendix 2: plate 2, p165.

And

Class B (enactment)
F+
This is *how* the teacher elicited the key words indicating the contents by means of directed questions to the students and she accepts their suggestions.
T. " Once something is moving, what kind of energy is making it move?"
L's. "Movement energy."
T. " Can you think of another word for that?"
L. " Kinetic."
T. " That's the one, we also learnt the new word was kinetic energy. Where would the car get the energy from?"
L. "The petrol."
T. "From the petrol. The petrol is the fuel. "
(Extract taken from lesson 1, 14/08/02, 10.55am)

Class C (planning level)
F++ See teacher's planning notes. *Appendix 2: Plate 3 a & b, p166-167*

Class C (enactment)
Once again the teacher elicited the key words indicating the contents, by means of directed questions to the learners and she accepts their suggestions. These words were written on the chalkboard.
F+
T. "Leon, what do you mean by kinetic energy?"
L. "Moving, Miss."
T. 'Yes, is moving energy, yes. Um, there was another new word we used, for example, look at this. What is it, what do we call it?"
L. "A cell."
T. "If it's just sitting here it looks like it can't do anything?"
L. "Stored energy, Miss."
T. " Yes, stored energy, so there's energy inside here. Potential. Potential, What does that mean .Cal?"
L. "Stored energy. "
T. "So there are different forms of energy."
(Extract taken from lesson1, 07/08/02, 10.55am)

<u>1.2. 1. Sequencing</u>

Instructional context

Discursive rules

Class A (planning level)

Here the teacher explains *how* she decides the order in which things will happen. In this case she decides that she will follow the same order of lessons pre-determined in the materials she is using. However she will add more activities and/or delete some, as she feels is necessary, as they go along, depending on time constraints and the needs of the children. She seems to build this flexibility into her plans.

F+

T " Because the science is already worked out we... with GETINSET workshop...."

R "So you follow the sequence suggested in the book?"

T " Yes, but we will improve, or I will say, we would add certain things to it or something, like for instance, I know for a fact we won't to get to the torch, we have three weeks. But if some children, um, express some interest, then I will let them build the torch but they still have to make some models and other work still has come through.

R. "So you won't require every child to do that torch?"

T. "No."

(Extract taken from teacher interview 05/09/02)

Class B (planning level)

Here the teacher also explains that although she had a sequence in mind there was some flexibility in implementing this sequence. She was prepared to change the sequence when necessary.

F+

T. 'Before this we've gone, um, from electricity to lightning and then we've done fuels. The electricity lesson was something that didn't fit in the sequence but because these others were a step behind in the Afrikaans class I decided to quickly let them catch up, so the electricity should have followed.'

(Extract taken from teacher interview, 14/08/02)

Also see examples of sequences of learners work. Appendix 2: Plates 4a-f, p168-173.

Class C (planning level)

F+

See example of sequence of learner work over time. This was the same for all learners Appendix 2: Plates 5, p174-177

Class C (enactment)

This teacher spoke about her micro-sequence within an activity.

In the activity, she taught the children the specialized names for the objects and apparatus under discussion. Then each group discussed the task. The children then made an electric circuit in each group using the apparatus. Thereafter the group did a group drawing produced by the reader/writer under instructions from the learners in the group. The drawing was displayed on the chalkboard. The teacher and class reviewed the contents, and finally each child redid the drawing task on an individual basis. But she explains that not all lessons follow a similar sequence.

F+

R. "Do you always go from group to individual?"

T."I don't want all group sessions to be the same."

(Extract taken from teacher interview, 08/08/02)

1.3.1. Communicating instructions

Regulative context

Hierarchical rules: teacher-learner

Class A (planning level)

Here the teacher hands out pre-determined sets of instructions in the form of task cards
F++
See instructions on learner task cards. Appendix 2: Plate 6, p178
(Lesson 1, 04/09/02, 9.30 a.m.)

Class A (enactment)
Here the teacher determines that the interactions between learners should take in small groups of three to facilitate the handling of equipment
F+
T. "You must make the light bulb work using one light cell and two wires. You'll be working in pairs but I think because there are wires, a cell and I think you should be working in threes. Three of you work with one cell, one light, and two wires."
(Extract taken from lesson 1, 04/09/02, 9.35am)

Class B (planning level)
Here the teacher hands out pre-determined sets of instructions in the form of task cards
F++
See examples of instructions on learner task cards. Appendix 2: Plate 7, p179

Class C (planning level)
Teacher is speaking and writing instructions at the same time. She has predetermined instructions printed on worksheets but reiterates them verbally whilst writing them on the chalkboard.
F++
T. 'Number one. The reader will read the instructions to the group, will read the instructions on the worksheet.
Number two. Group must try and do what is on the worksheet, try and build what it asks on the worksheet.
The third instruction goes through the experiment and, number three, can answer the question on the worksheet.'
(Extract taken from lesson1, 07/08/02, 11.00am)

1.3.2. Communicating with others

Regulative context

Hierarchical rules: teacher-learner

Class A (enactment)

Here we show *how* the teacher interacts with learners by asking questions to elicit children's ideas, which she accepts. So she privileges an interaction between teachers and learners although she is in vertical relation to the learners controlling the type of questions asked.

F-

T. "Look at that iron on the stove. What else do we do on the stove?"
L1 "We cook."
T "So where does the energy come from for the lamp?"
L2 "Paraffin."
T "And the lady sweeping?"
L3 "Food."
T. "And there's a kettle."
L4 "It comes from gas'."
T. "What does the kettle do?'
L5 "Boils the water."
(Extract taken from lesson 1, 04/09/02, 9.10am)

Class B (enactment)

Again we show *how* the teacher interacts with learners by asking questions to elicit children's ideas, which she accepts. So she privileges an interaction between teachers and learners although she is in vertical relation to the learners controlling the type of questions asked.

F-

T. "It gives the stove the energy to work?"
L1. "In the home."
T. "What about, what about the home?"
L2. "Lights."
T. "It gives light. What more? Think of one thing you used this morning which works with electricity."
L3 "The TV."
T. "A TV."
L4. A heater."
T. "So this electricity somehow has the electricity that we can use in our home."
(Extract taken from lesson 1, 14/08/02, 11.15)

Class C (enactment)

In this class too, we show *how* the teacher interacts with learners by asking questions to elicit children's ideas, which she accepts. So she privileges an interaction between teachers and learners although she is in vertical relation to the learners controlling the type of questions asked.

F-

Child is helping the teacher to demonstrate making a circuit.
T. " Hold it here, we attach the two wires here. That is what the group said, the two reporters told me. Just hold it there for me please. Just hold it for me, don't worry it won't shock. Ah, and it's not working. Why do you think it's not coming on? "
L " The sellotape."
T " Oh the sellotape might be in the way, hey. "

Extract taken from lesson 1, 7/8/02, 11.10 a.m.)

1.3.3. Communicating feedback

Regulative context

Hierarchical rules: teacher-learner

Class A (enactment)
Here the teacher gives feedback to the whole class about how to label a drawing. She points out the specific structure on the drawing and explains how the label line should extend out from the structure.
F+
T. "Remember, when we label we move from wherever we are talking about, out. Look there behind me. "
(Points to picture behind her on the board)

T. " If you are telling me something is touching the metal casing, then I need to see the line must be touching the metal casing before you give me the label 'metal casing'."
(Extract taken from Lesson 1, 04/09/02, 9.30 a.m.)

Class B (enactment)
Here the teacher acknowledges the learners contributions and uses them to develop the discussion in the classroom
F+
T. " In this group, Jekwa had a theory about coal and Gideon had a theory about coal and the four of them had to decide which theory is right. What was your theory?"
L. " A volcano."
T. "His theory was that coal comes from volcanic eruptions. What comes out of a volcano?"
L. "Lava."
T. "Gideon said to them it was plants and trees and then sand and mud and stone covers it. And which one did you choose out of the two theories?"
L. "The volcanoes."
T. "Ok we will find out."
(Extract taken from lesson 2, 20/08/02, 9.35)

Class C (enactment)
Here the teacher is giving general feedback to the whole class focussing on how to correct their drawings of a circuit. She is pointing out the specific corrections on a displayed drawing from one of the groups, by way of example.
F+
T "Some groups, and I can see it on some of the drawings, right? This drawing here; can anybody tell me what is wrong, just with this section here, these two wires pointing to the globe? Yes?"
L "The wires are to the bottom."
T " The wires are both showing to the bottom part of the globe. Right? Will it light up?
L "No."

T One wire must be showing on the side of this metal here, and one wire at the bottom. So be careful when you do your drawings."
(Extract taken from lesson 1, 7/8/03, 11.20 a.m.)

1.4.1.Communicating time allowed for exploring texts and themes under study

Instructional context

Discursive rules

Class A (planning level)
Here the teacher explains how she allows for time flexibility so that all learners can complete their tasks (and at the same time the teacher also creates time for herself so that she is available to all the students when they need her attention.
F-
T. "So that if the child doesn't complete the task today, he can have another opportunity and complete it, say tomorrow, whenever. But the faster one, if we saw today with the circuits, I could see that that, there were three groups who is working at a much faster pace, so the other children will still get that opportunity to finish their drawing. But the brighter lot they want to get on to the writing part- so because then the writing takes long then it will give me the opportunity to asses them sort of one to one."
(Extract taken from teacher interview, 05/09/02)

Class A (enactment)
Here the teacher reminds the learners about how much time they should spend o their examination of the batteries so that there is time for the next task.
F+
Speaking to the whole class.
T. "Please do not spend too much time looking at the battery, I need you to carry on. Five minutes."
(Extract taken from lesson 2, 05/09/02, 9.20am)

Class B (enactment)
Here this teacher also reminds her class about how long they have for the discussion and then calls an end to it so that they can turn their attention to the next activity.
F ++
T. "Five minutes only (for discussion about coal in groups).......... OK our five minutes is up .Can I have your attention now?"
(Extract taken from lesson 2, 20/08/02, 9.20am)

Class C (enactment)
Here this teacher also reminds her class about how long they have left to complete the activity and then calls an end to it, even though some have not yet completed the task, so that they can turn their attention to the next activity

F++T. 'And your time is moving on.' I said 10 minutes and you only have 4 left. So get on with the question. In 4 minutes I'm going to call up the runners .I'm coming to check how far you are now stop, even if you are not finished."
(Extract taken from lesson 1, 7/8/02, 11.15 a.m.)

1.5.1 Communicating criteria for learner social behaviour

Regulative context

Hierarchical rules: teacher-learner

Class A
Not seen

Class B (enactment)
Here the teacher also refers to behaviour norms, which are not written down.
F+
T. 'In your group please, not everybody speak at the same time, and make sure that everybody has a chance to say what they want to say, don't let one person dominate."
(This is followed by intense discussion in the groups)
(Extract taken from lesson 2, 20/08/02, 9.20am)

Class C (planning and enactment level)
Here the teacher had a written set of rules for behaviour on permanent display at the front of the classroom. She told me that they had been developed in collaboration with the learners. So they are strongly framed on the planning level
(The teacher planned for these to be generated and they were a permanent fixture in the classroom). However they are weakly framed at the enactment in terms of the individual learners participation in their development.
F++ (planning)
F- (enactment
See example of classroom rules for behaviour generated by teacher and learners and permanently displayed on the classroom wall. Appendix 2. Plate 8, p180

1.5.2 Communicating criteria for realisation and assessment

Instructional context

Discursive rules-evaluation criteria

Class A (planning level)
Here the teacher explains how she uses assessment criteria. She communicates them by writing and permanently displaying generic assessment criteria for five common forms of communication on the classroom wall. The generic criteria were developed by a group of teachers and INSET workers in the GETINSET project. The teacher used them as a guide and then contextualised them to fit a specific task in collaboration with the learners.

F++

T. 'Every time, for me it is important a child should know exactly what he is doing, and it's important for me to know what I am looking for, it makes my assessing so much easier. So that is why the assessment must be absolutely clear, so that the child (and) I know what I am looking for and the child knows what's expected from him.'

(Extract taken from teacher interview, 05/09/02)

Also see photographs of permanently displayed assessment criteria, and assessment criteria on the chalkboard. Appendix 2: Plates 9 a, b and c, p181-183

Class A (enactment)

Here the teacher negotiates with the learners in order to contextualise the criteria for a specific task.

F+

Teacher is explaining and eliciting the criteria for a drawing. She also provides some ideas about the content of the task.

T " What is the criteria? First, the most important thing? What is meant by clear lines?"
L " They must be nice and dark."
T " Be more explicit."
L "Miss, they must be able to see what's battery line and what's the wire."
T "Excellent. I must be able to see exactly what you are connecting. Where must the lines go?"
L " From the cell to the bulb."
T "But there are two things to the cell and two things to the bulb. What are the two things? There's a negative side to the cell. There's a positive side to the cell. So your lines must show which end is positive and which end is negative."

T "What else am I looking for in this drawing?"
L "The correct information"
T " What is the correct information? Meaning positive, negative, side, casing. That is your correct information."
L "Heading"
T "It must have a heading."
L "Colour."
T "There must be a bit of colour."
L "Label."
T "What labels am I looking for?"
L "Positive end. "
L "Negative end."
L "Metal casing."
T "If I don't want to use the label 'metal casing', I can use 'side of the bulb'. Something else?
L "It must represent the object."
T "Represent the object. Can I draw a dog when I am busy with a light bulb/"
L "No."
T " So you go ahead and draw."
Teacher draws attention to the size of the page.
" I don't want to use a magnifying glass to see your drawing."
(Extract taken from lesson 2, 05/09/02, 9.00am)

Class B (enactment)
Here the teacher explains that she tells the learners what the criteria are for a given task. She did not go into more detail and I saw no evidence of this in the short space of time I was in the classroom.
F++
"Generally when they do the written task that's normally when I tell them this, um' is what I am looking for and this is what I'm going to mark."
(Extract taken from teacher interview 20/08/02)

Class C (planning level and enactment)
Here the teacher explains how she arrived at the criteria and communicated them.
F++ (planning)
F+ (enactment)
"Yes I give them the criteria, sometimes they give me the criteria.... I have one set of criteria (for all levels of learner) and I want them all to be on the same standard."
(Extract taken from teacher interview, 8/8/02)

<u>1.5.3. Communicating criteria for satisfactory completion of tasks through dialogic evaluation</u>

Instructional context

Hierarchical rules: teacher-learner

Class A (enactment)
Here the teacher communicates that she will come and check the work. She gives feedback to the learner so that the learner knows what still has to be done for full completion and also praises the learner about his own understanding of what is needed to complete the task.
F++
T. "When you have completed, just put up your hand and I will come and have a look."
Learner shows teacher the work'
T. "Now you're telling me that you have completed. Now look at your criteria. You got clear lines? Did you use colours?"
L. "Yes"
T. "What else must you check"?
L. "Heading, Miss."
T. " Do you have a heading? Marvellous."
(Extract taken from lesson 2, 05/09/02, 9.30am)

Class B (enactment)
Once again the teacher communicates how to proceed in order to complete the task and then asks the learners to check how many appliances they have managed to identify in the allotted time. Then she begins to check their work.

F++
T. "I am just quickly going to give you a picture and you identify all the electricity appliances as well as what is happening in them. In your groups, three minutes, you don't have to write them down, just speak about them, all the ways the family is using electricity. O.K., now count. How many have you got so far?"
(Extract taken from lesson 1, 14/08/02, 11.05am)

Class C (enactment)
The teacher once again explains the procedure for completing the task and puts the onus on each child to complete his/her own work. However the assessed examples provided show that this teacher accepts partially completed work from some learners who appear to be mostly second language English users. The partially completed nature of their tasks may represent limitations as a result of language difficulties and at this stage in their language development the teacher is willing to be flexible about accepting whatever they are able to produce.
F+
T. "So I am going to hand out a sheet to the runners and that sheet is for you to answer the questions on your own; not with your group, and that you are going to do in your science books."
(*Extract taken from lesson 1, 7/8/02, 11.40, a.m.)*
See assessed examples of learners incomplete work. Appendix 2: Plates 10 a & b, pp184-185

2. Presentation of data for classification

<u>2.1.1. Insulation of content (between learning areas)</u>

Instructional context

Discursive rules –insulation of content (between learning areas)

Class A (planning level)
Here the teacher describes how she integrated the content from different learning areas into a single narrative
C--
T. "But it's part of the narrative, the child, sometimes it won't even know it's doing maths, they won't know when they are doing science, because science, when they are doing science they are doing maths without being quite conscious of it. When they are doing life orientation they remember, 'but I heard that in mining', so now they are associating them. So the dangers, for instance, don't just occur in the real world, but in our homes, the very little things that we do. I would associate them, all the time I am giving them the link.
(Extract taken from teacher interview, 05/09/02)

Class B
Not seen

Class C
Not seen

2.2.1. Insulation of content between teacher's knowledge and learners' knowledge

Instructional context

Discursive rules

Class A (planning level)
Here the teacher describes how the learning contents include aspects of the children's knowledge, which the teacher recruits into the learning programme.
C-
T. 'Visually, our children watch Tube (children's TV programme) all the time and, um, sometimes there is a schedule that appears on TV and I'm always telling my kids at home, tell me when mining's coming up, tell me when whatever's coming up. So I use the television although we are not with the TV at that moment because the TV's in the library and this happens on the Saturday. So indirectly I'm giving them homework or very incidentally, I ask them. I am always trying to find out what exactly it is that they know. A lot of the time the lesson will actually come out of what they know. When I asked them who watched Tube on Saturday and what can you tell me happened there and then I said then I will be discussing mining and then suddenly all the ideas will be coming out and then I'll ask them what do you think mining is and then I'll show them a book because we don't have the actual mines here. There are no mines we can take them to. I'd show them a book to give them some idea of what a mine looks like................So I'm always associating with the outside world...............consciously. It's part of my teaching. It's part of I believe in developing the child holistically.'
(Extract taken from teacher interview, 05/09/02)

Class A (enactment)
C-
T. " I asked you yesterday to go and find out (at home). About anything that you can find out about batteries, What else uses batteries?'
L. 'For toys."
T. "To operate toys. Who else has toys that use batteries?"
L. " A doll that walks.
L. "A car."
T. " Where do we use these flat batteries? You said they are used for watches. The small ones? Yes."
L. "They cost you about R10 and then you've got to go to the jeweller to replace them."
(*Extract taken from lesson 1, 04/09/02, 9.05 a.m.)*

Class B (enactment)
Here the teacher elicits learning contents from aspects of the children's knowledge, which the teacher recruits into the learning programme.
C-
L. "Miss, my grandpa bought a new heater, but it looks nice Miss, but it doesn't make the house warm. So the post came and so the bill was high, Miss, just because of the heater. "
T. "Is it? You can literally see. Just ask your parents to dig up an electricity bill from round about February, March and then you take one of this month, one of the winter months and you can compare them and you can see how much more electricity we use during winter compared to summer.
(Extract taken from lesson 1, 14/08/02, 11.15am)

Class C (enactment)
Here the teacher elicits learning contents from aspects of the children's knowledge, which the teacher recruits into the learning programme.
C-
T. 'Where are we getting our lights from, here at home, and at the shop and that?"
L. "ESCOM. "
T. "Where is our nearest power station here?"
L. "Athlone."
T. "Mr. Erikson (a worker at the school), on his bicycle, what did he show that lights on his bicycle?"
L. "A dynamo.
(Extract taken from Lesson 1, 7/8/02, 11.00 a.m.)

<u>2.3.1. Insulation between spaces (seating arrangements)</u>

Regulative context

Hierarchical rules: teacher-learner

Class A (planning level)
Here the teacher has designated three large groups in the classroom comprising between fifteen and twenty children in each group, sitting in rows of desks facing each other. These groups are based on 'ability' as evidenced by their performance in the class. However the teacher will move the children through to another group depending on whether their performance improves or falls off.
C+
T. ' I used to have them mixed, where I had, um, my average student mixed with a brighter student and then the far slower student, but in the end that didn't work, because I could see that the brighter student was becoming frustrated because it meant that the entire group had to wait for the slower student................
I decided I'll put all brighter ones together, all middle ones together and all the weaker ones together for the simple reason that the weaker one can work at its own pace.'
(Extract taken from teacher interview, 05/09/02)

Class A (enactment)
In this class I observed the seating arrangements. Learners sit in groups of 6 in close proximity when working on tasks but their seating arrangements are changed periodically. (Also see allocation of roles)
C+
See diagram showing seating arrangements in class A: Appendix 2: Plate 11, p186

Class B (enactment
Observations made showed that there were 60 learners in one lesson observed and about 30 learners in the other as sometimes the class splits into two for certain science lessons run by an auxiliary teacher. When this happens a different classroom is used with its own arrangement of desks and spaces. During the course of each lesson learners were called out to, or arrived from, other duties. I saw two different classroom venues and in each the desks or tables were loosely arranged in pairs or in threes.
C-
T. "Well when they come to my class they sit in their own groups. We say five or six in a group. They just sit where they want to sit"
(Extract taken from teacher interview 20/08/02)

Class C (planning level
Here the teacher describes the seating arrangements. Each group sits at a pair of desks facing each other. The size of each group is probably also determined by the fact that the pair of desks can only accommodate four learners with comfort. One learner in this class sits at a desk on his own. The teacher told me he had been identified as having learning and attention difficulties and she reported that he seemed easier to manage and happier on his own.
C++
T. "This year I made the groups smaller and so I only have 4 (in a group)"
T. "So this year I thought, no rather let the learners all learn from each other and that is how I grouped them together. Now I know that there is at least one child in the group who knows what is going on and the others will learn more or less from this one and I try and encourage a lot of sharing."
(Extract taken from teacher interview, 8/8/02)
(Also see assigning roles for class)
See diagram of class C seating arrangement. Appendix 2: Plate 12, p187

<u>2.4.1. Indicator for degree of insulation between learner roles</u>

Regulative context

Hierarchical rules: learner-learner

Class A (planning level)
Here the teacher explains how she assigns roles to different learners. This in turn determines how different individuals should interact with the materials and the task and each other. The learner in the role of recorder takes notes about what is discussed or needs to be recorded in the task. The reporter has the task of preparing and giving feedback from the group to the class or other groups. The reader makes sure that any

instructions or information is read and understood by the group. The materials handler fetches and carries the materials and apparatus and instructs the group on its proper use. The timekeeper keeps check of the time and keeps the group informed of their progress time-wise. The coach helps the members of the group if they are experiencing difficulties in understanding or keeping up with the rest.

C+

T. 'There are 6 roles, one has to be the recorder, the reporter, the reader, um, what are the other three, the materials handler, the timekeeper, and I can't get to the other one, oh and the coach.

Each child has a role to play, it is important for a child to know that at some stage he has to make a decision and its also important t for them to know that they have a vital role to play no matter what role they play. It gives them a sense of belonging and it makes them confidant because the child who plays the role of coach is very confident that week and then the following week they reverse, they go anti-clockwise.

R. "OK"

T. "So each will get a turn to be...this week is the coach the week after, the following week, someone else is the coach, so I can get to hear each child report eventually."

(Extract taken from teacher interview, 05/09/02)

Class B

In this class no roles were assigned and learners did not appear to assume specific roles themselves, however there was a high level of interaction generally.

Not seen

Class C (planning level

Here the teacher describes the different roles, which are similar to the ones described in class A, and gives her reasons for assigning them. She goes on to explain how she uses the role of runner to assist her in managing the smooth running of the activities.

C++

T. "Monitor, runner, reader/writer, fourth role is reporter.

I don't have a lot of very strong readers in the class. Learners who can read and understand and perhaps explain to someone else what needs to be done. So what I've done.... I've taken the good readers and most of the good readers are good writers. So the reader/writer is the same person for that reason."

T. "Each and every person does not have to put the book on my table. They just give it to the runner and the runner brings it back. For handing-out purposes, I just call out the top name (on the books) and the runner knows these are my group's books and fetches them."

(Extract taken from teacher interview, 8/8/02)

Class C (enactment)

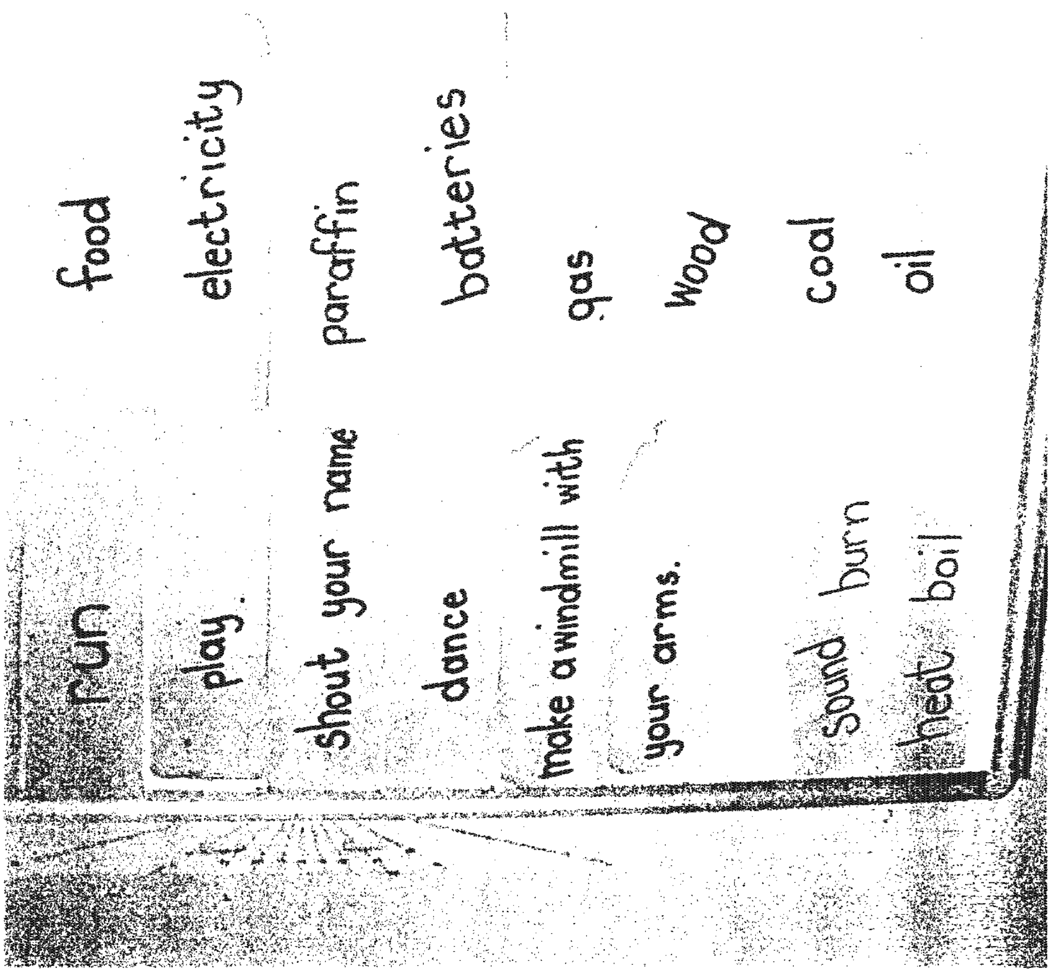
C++

The runner collected and returned the books and apparatus to the teacher. The reader/writer read the task sheets and wrote on behalf of the group.

T. "The runners are going to come up quickly and get a sheet for the group. One sheet for the group."

(Extract taken from Lesson 2, 8/08/02, 11.00 a.m.)

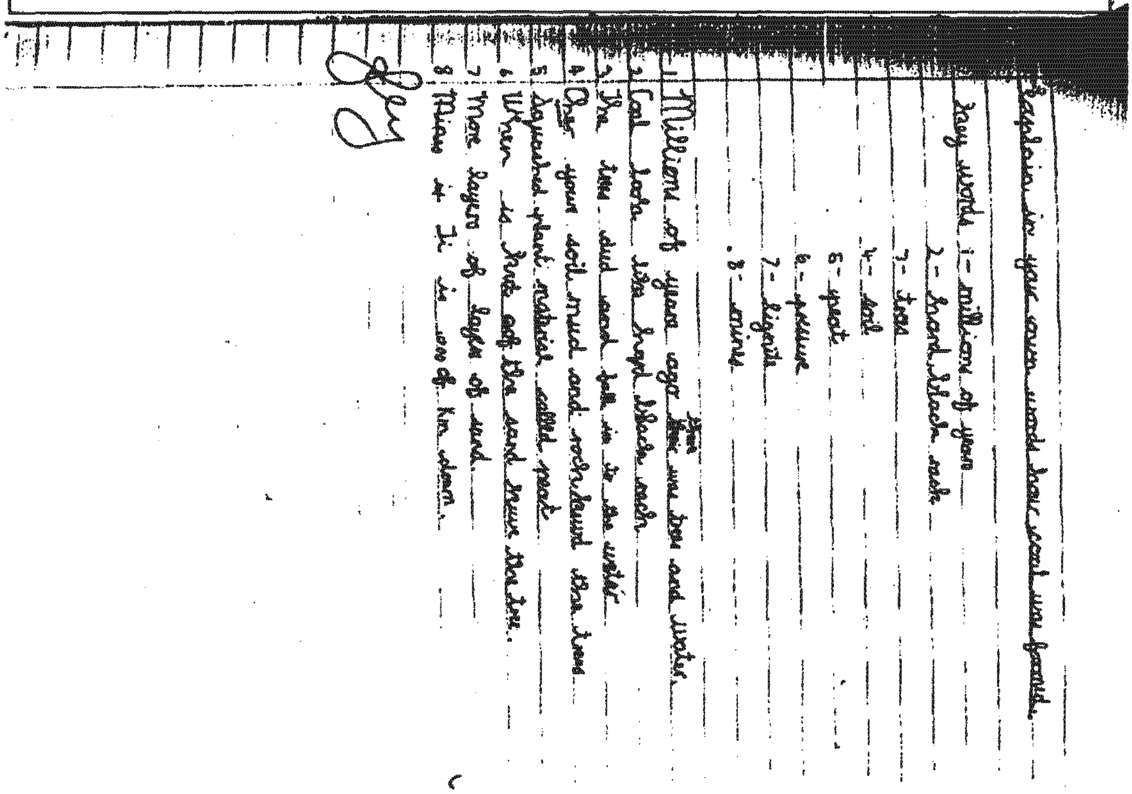
Page 164
Plate 1 List of key words
Class A



Page 165

Plate 2 List of key words in learners work.

Class B



Explain in your own words how coal was formed.

Key words 1- millions of years
2- hard black rock
3- trees
4- soil
5- peat
6- pressure
7- lignite
8- mines

1 Millions of years ago there was trees and water.
2 Coal look like hard black rock
3 The trees died and fall in to the water
4 Over your soil mud and rock buried the trees
5 Squashed plant material called peat
6 When is heat aof the sand have the tree.
7 More layers of layers of sand.
8 Mines it is [illegible] of km down.

Plate 3a Teachers plan with key words Class C

ENERGY (...

OUTCOMES *Learners should be able to*	ASSESSMENT *How will I know if they can do it?*	ACTIVITIES *What must the learners do in the classroom so that they can learn how to do it?*	METHOD OF ASSESSMENT	RESOURCES
Identify and recognize when energy is being used.	When they can identify energy-based activities.	Learners are given pictures. They write a sentence under each picture to say what activity is taking place eg. lifting, frying, running, etc.	Educator checks and marks the sentences.	Pictures, people/ thi... using en...
Identify and name the Sun as the main source of energy.	When they can identify the Sun as the main source of energy.	Give learners a series of pictures related to the food chain eg. Sun → grass → cow → milk → human. Learners are to place these pictures in logical order. Ask learners which picture is in all the sets and why it is always placed first. Learners will do this as group work.	Groups report their answers to the class.	Pictures
Identify and name energy sources other than the sun.	When they can identify energy sources other than the sun.	Groups are given a picture with people doing different activities eg. driving, cooking. Groups must discuss where this energy is coming from eg: petrol, gas, electricity.	Groups write answers on strips of paper and paste onto chalkboard. Learners deduce energy sources.	Picture Slips of Prestick Khokis

ENERGY

OUTCOMES *Learners should be able to*	ASSESSMENT *How will I know if they can do it?*	ACTIVITIES *What must the learners do in the classroom so that they can learn how to do it?*	METHOD OF ASSESSMENT	RESOURCES
Use energy sources to draw a mind map.	If they can draw a mind map.	Groups use slips from previous lesson to decide what the sources of energy are. Groups make a mind-map of these.	Educator checks and marks mind-maps after groups present.	Newspri Crayon Slips fr previous lesson
Give examples of energy sources.	When learners can identify examples of energy sources	Learners use mind-map from previous lesson. They cut pictures from magazines to use as examples of sources of electricity eg. electricity – stove.	Groups report findings to class.	Magazin Glue, Sc Newspr Mind- r
Identify renewable and non-renewable sources of energy.	When learners can identify renewable and non-renewable sources of energy	Groups use mind-maps to discuss what sources are renewable and what sources are non-renewable. Individually learners write sentences suggesting how non-renewable resources can be preserved or made renewable.	Individual sentences are checked and marked.	Mind-m Note E
Recognize that energy can be changed or transferred, draw a flow chart	Draw a flow chart showing the transfer of energy.	join pictures together to create a flow of energy chart eg: electrical → heat → light. Repeat activity with individual task.	Educator check and marks individual flow charts.	Newspr Crayon Notebo
Display Data Collect Data	Have they collected and displayed data correctly.	Learners draw graphs of how they use energy in their homes.	Individual assess. of graphs.	Graph f Question

Page 167
Plate 3b Teacher's plan contd.
Class C

Plate 4a Sequence of learner work (4a-f). Class B

CONCEPT: What is energy?

SKILLS: Examine, Compare

ACTIVITY:
1. Study the pictures and complete the table below.
2. Compare what you have written with what other members in your group have.

What is happening in the picture?	Is work being done?	Does it cause any changes to take place?
[illegible]	yes	[illegible] yes
[illegible]	yes	[illegible]
the man [illegible]	yes	[illegible] yes
[illegible]	yes	[illegible] yes

CONCLUSION:
1. Energy makes [illegible] Energy makes.
2. Energy makes Energy makes.
3. Energy makes energy makes.

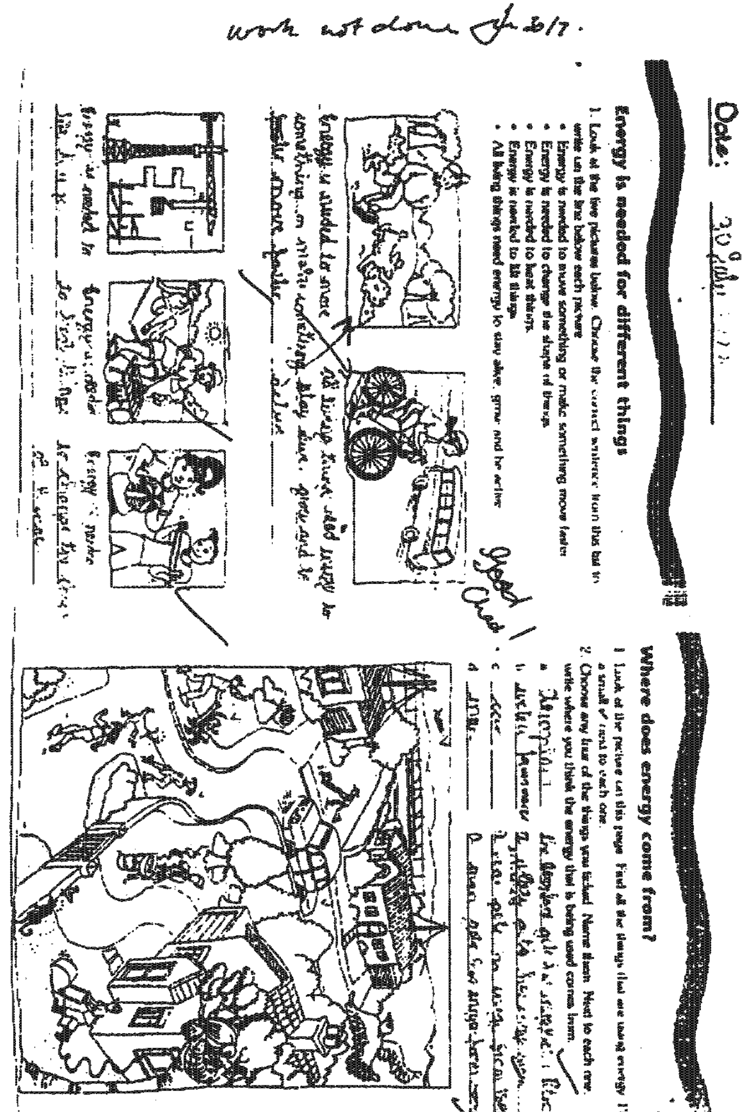
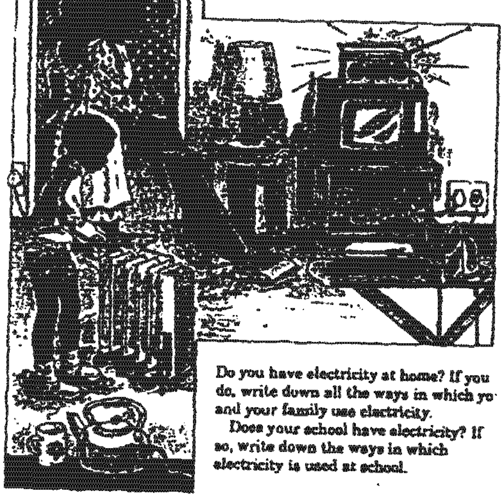


Plate 4b Sequence of learner work contd.

Class B

Is electricity useful?

Many people have electricity in their homes. Here is a picture of Thozamile's family at home. Look at it carefully and find all the ways in which they are using electricity. Write them down.



Do you have electricity at home? If you do, write down all the ways in which yo and your family use electricity.

Does your school have electricity? If so, write down the ways in which electricity is used at school.

There are many people who don't have electricity at home. Leila's family has no electricity. They must find other ways to do the things that electricity does in Thozamile's home. Look at this picture of Leila's family and write down all the things they use instead of electricity.

Did you know?
20 million people in South Africa don't have electricity in their homes.

Is your home without electricity? If so, write down what you use instead.

Which do you think is better — to be with or without electricity? Discuss this question with three friends from your class. Then tell the other people in the class what you think.

Find out
Why do some people where you live have electricity, and some not?

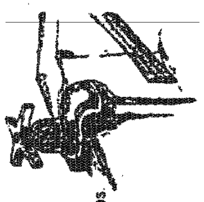
electricity energy

1. The T.V.
The T.V. is a sumthing that woc with electricity energy it is sumthing that a lot of energy.
2. The tape
The tape geevs electricity to. it geevs sound energy.
3. The heat.
The heat is a energy that geevs heat energy.
4. The vakoom.
The vakoom cleen is sumthing that sukis up dust.
5. The iron
The iron is sumthing that can make your inlows nis.
6. The ketl
The ketl is a theng that you can make sum thing of.

everthing in my hous

1. Ou lust wake with electricity energy.
2. Ou tape wake with electricity energy.
3. Ou fane wake with electricity energy.
4. Ou vakoom wakse with electricity energy.
5. Ou iron wake with electricity energy.
6. ketl Ou ketl wake with electricity energy.

How to attract a thin stream of water



- Open a water tap very slightly. Let a thin, smooth stream of water flow out.
- Charge a plastic ruler by rubbing it against your hair or your clothes.
- Slowly bring the ruler close to the water.

What happens? Can you explain this?

Page 170
Plate 4c Sequence of learners work contd.
Class B

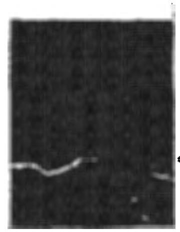
work not done

EXPERIMENT

1. Press a large lump of plasticine onto the middle of a very big baking tray or a small tin tray. Press it hard so that it sticks well.
2. Put the tray down on a very large, thick plastic bag. A rubbish bag will be large and thick enough. Hold the plasticine lump and rub the tray round and round on the bag.
3. Pick up the tray by the plasticine. Hold something made of metal, such as the lid of a tin, close to one corner of the tray. I held the lid with a wooden peg, so that your hand doesn't get hurt. You'll see a big spark jump from the tray to the tin. Try to do this in a dark room so that you see the spark better.

Find out

1. How do lightning conductors protect houses and buildings from lightning?
2. What can we do to protect ourselves from lightning during a storm?

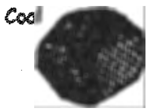
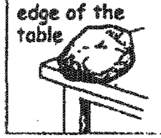


This tall building has a lightning conductor on it which stops the lightning from damaging the building.

To photocopy for

Activity 4

Learner Task Card

Coal 	When you burn it	heat + light energy	change to heat + light ✓
A stone on the edge of the table 	When it fall	movement + sound energy	change to movement + sound ✓

2. Write sentences to tell what you did to get the energy out of each thing e.g. There was stored energy in the candle wax. I burned the wax to get heat and light energy from it.

incomplete

(a) ______________________

(b) ______________________

(c) ______________________

(d) ______________________

(e) ______________________

(f) ______________________

(g) ______________________

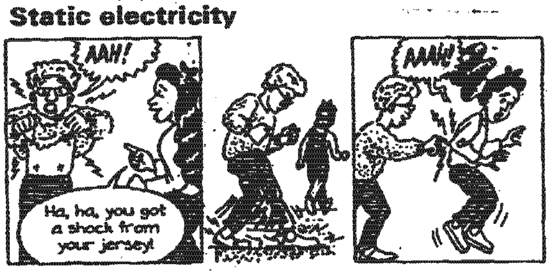
7/7

Page 171
Plate 4d Sequence of learners work contd.
Class B

POTENTIAL ENERGY
(STORED ENERGY)

1. When our bodies or an object has energy stored inside of us it we say it has POTENTIAL ENERGY.
2. Food, batteries, wood, stretched elastic bands, candles and other fuels all bands have the potential to make something happen or to bring about change.
3. We get the energy out of food when we eat it or
4. When we release an elastic band, we get the energy out of it.

Static electricity



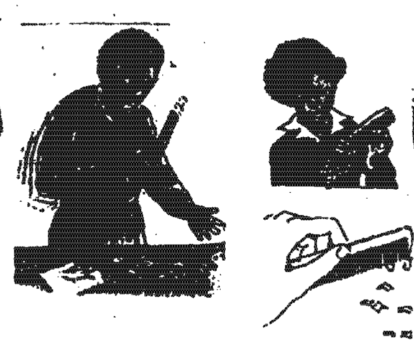
Talk to a partner about this comic. Why do we sometimes get shocks when we take our jerseys off or when we rub some carpets while wearing rubber shoes? The following activity will help you to understand what happens.

INSTRUCTIONS

work not done!

Making an electric charge

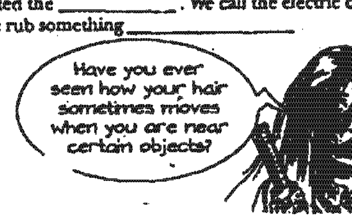
...u will need a plastic ruler for part... a piece of paper



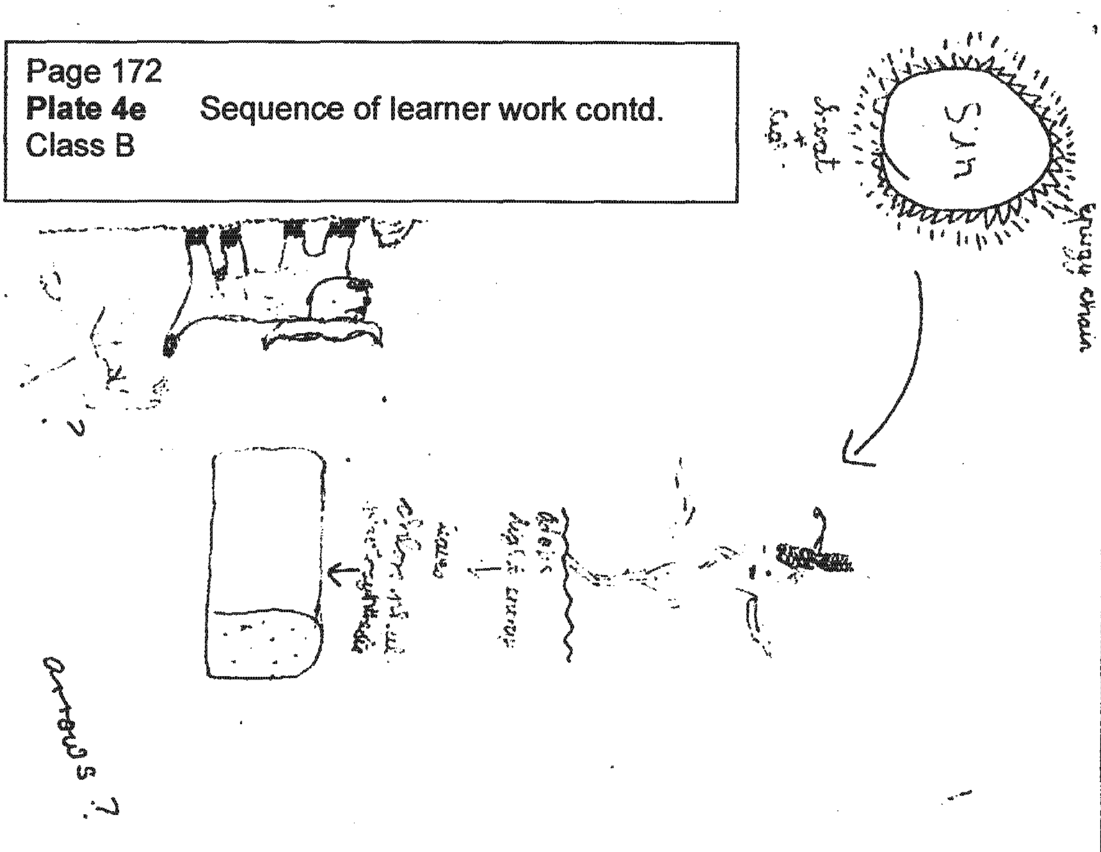
FILL IN THE MISSING WORDS.

Picking up pieces of paper using electric charges

When some objects are______, they get an electric______on them. The objects can then______other objects. We saw this when we rubbed the plastic ruler. It attracted the ________. We call the electric charge that is made when we rub something________



Page 172
Plate 4e Sequence of learner work contd.
Class B



How coal is made in the Earth

Coal is a hard, black rock. For hundreds of years people have burned coal to keep themselves warm. It takes millions of years to make coal.

Millions of years ago there was a lot of water and many trees covered the Earth. Sometimes when trees died they fell into the water. Over many years, layers of soil covered the trees and turned the wood into peat, which is soft and can be burned for fuel.

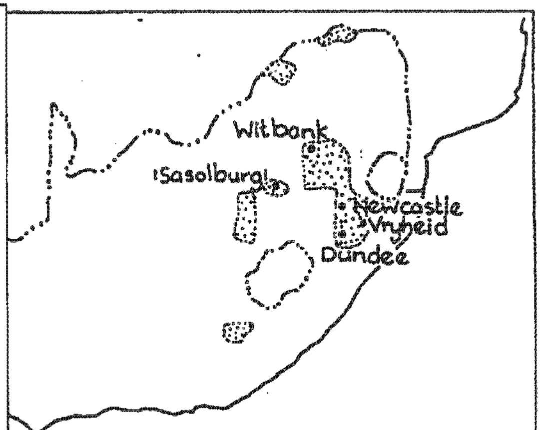
More and more layers of heavy soil on top caused more pressure so that gas and water were squeezed out of the peat. This made the peat change into a thin layer of hard coal or, into oil. The Earth takes millions of years to make the coal. This coal is formed very deep under the ground and so people have to dig mines to get it out. There are many coal mines in South Africa

Using coal

Most of South Africa's coal is used in Power Stations to make electricity. There is a big factory in Sasolburg that makes coal into petrol. A special form of coal called coke helps us to make iron into steel. Tar, plastic and fertilizers also come from coal. People use coal in their homes to cook food or keep themselves warm. If we continue to use coal, the world will soon run out of it. This is a great worry and many people are looking for different types of fuel in order to save coal. The Earth's oil will be used up by the year 2030 and coal by 2085.

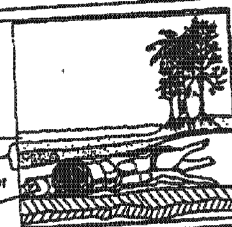
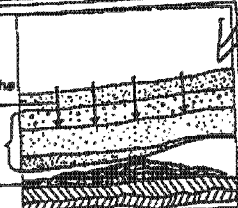
Coal in South Africa

South Africa has a lot of coal. Look at the map to see where we mine it.
We use most of our coal, but we sell some to Japan.



Page 173
Plate 4f Sequence of learners work contd.
Class B

Paste the story of how coal was formed in correct sequence on to your task card.

Pictures that tell how coal was formed	Paragraphs that tell how coal was formed
First 	Millions of years ago the Earth's climate was wet, so many plants grew near water. When these plants died, some fell into the water. They did not rot but in time layer upon layer of sand and mud covered them.
Then 	More and more pressure from sand and mud compressed and squashed this plant material into a harder layer. This layer is called lignite. As the compression took place gas and water were squeezed out of the dead plant material.
Next 	More and more layers of sand and mud fell on top of these dead plants. They slowly became squashed plant material, which we call peat.
Finally 	Over millions of years more layers of sand and mud covered the lignite. The lignite eventually became a hard black type of a rock called coal.

Page 174
Plate 5a Sequence of learners work (a-d)
Class C

Self-assessment – PO 9

What did I learn?
I learned a lot about electricity..
....
....

I really liked it when we I share wa my ....
Pencilcrayons...
....

I want to find out more about static electricity..........
....
....

This is a drawing of what I liked the best.

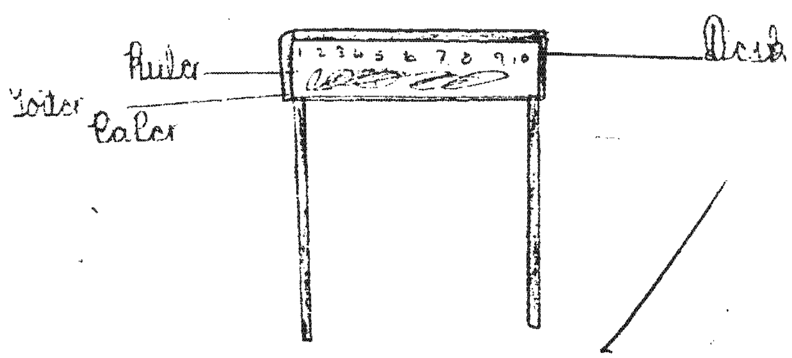


Plate 5b Sequence of learners work contd. Class C

Static Electricity

1. How is static electricity formed? by rubbing objects together.
2. Name one (1) object that uses static electricity to make it work. dynamo
3. What is meant by the word: FRICTION? rubbing
4. Write down the meaning of the words below.

energy: the ability to do work: force a push or a pull friction: rubbing

gravity: the force that pulls every-thing towards the earth.

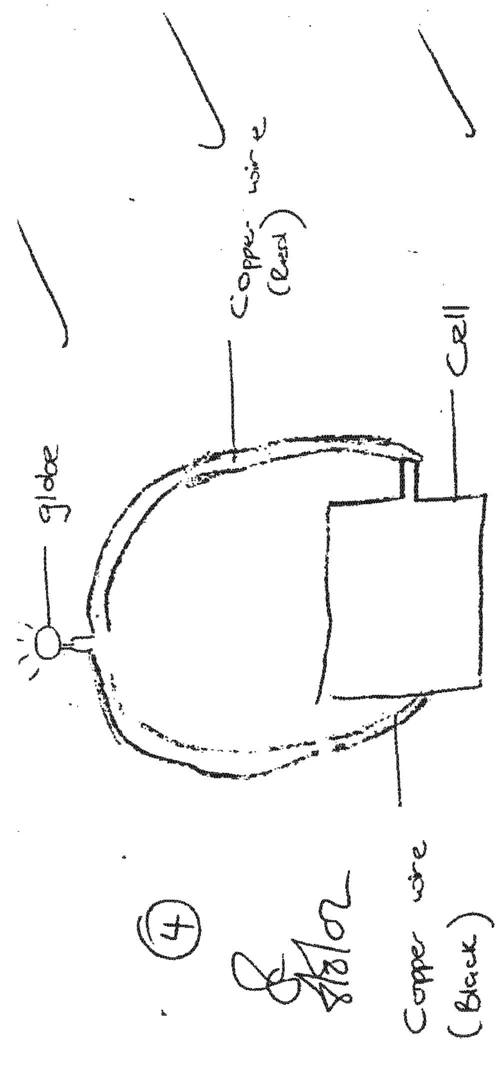
lubricant: substance needed to oil or greese something so that it moves smoothly.

magnetism: energy from a magnet to attract certain elements.

work: using energy to do something.

12/08

Page 176
Plate 5c Sequence of learners work contd.
Class C



Page 177
Plate 5d Sequence of learners work contd.
Class C

ELECTRICAL ENERGY

DATE 7 August 2002

1. What made the globe light up?
cell ✓

2. How many wires do you need to connect the cell to the globe?
two ✓

3. Electricity flows from the cell ✓ through the wires ✓ to the globe ✓ and back through the second wire ✓ to the cell.

4. Draw and label your experiment.

12/08/02

Page 178

Plate 6 Instructions on learner task card. Note criteria written onto page by learner. (Class A)

3 Write a paragraph to explain how you made the bulb light up.
Remember to write a heading for your paragraph.

How I made the bulb light up

Today in class I made a bulb light up. This is how I made it.

To begin with I connected the first wire to the positive end of the battery. ✓

Then I connected the other end of the wire to bottom of the bulb. ✓

Thereafter I connected the second wire to the side of the bulb. ✓

Finally I connected the other end to the negative end of the battery. ✓

criteria
Make sense 4
spelling 4
punctuation 4
correct info 4

Plate 6 Scan (5) 34

Page 179
Plate 7 Instructions on learner task card
Class B

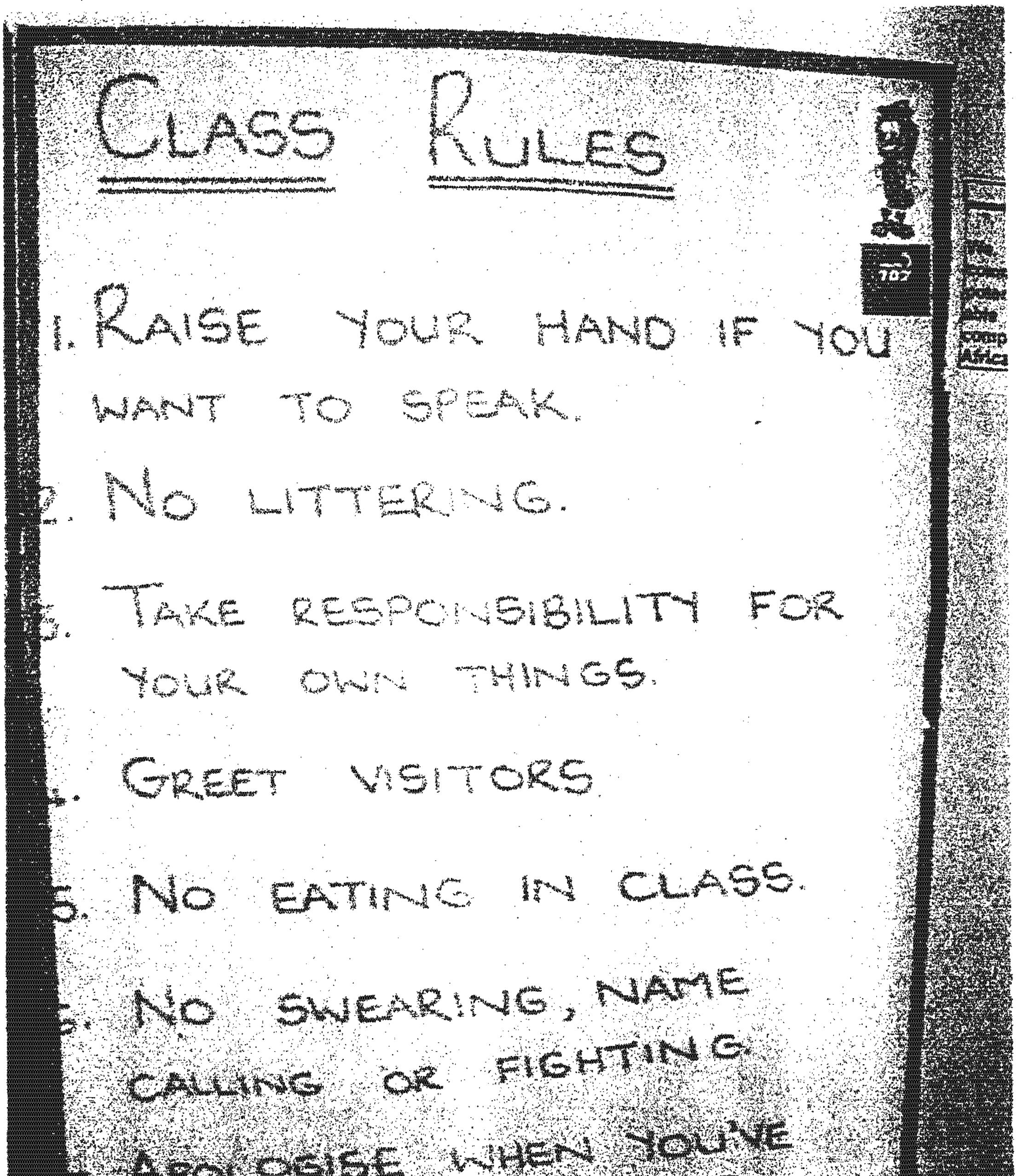
CONCEPT: What is energy?

SKILLS: Examine, Comp

ACTIVITY:
1. Study the picture below.
2. Compare what you have written with what other members in your group have.

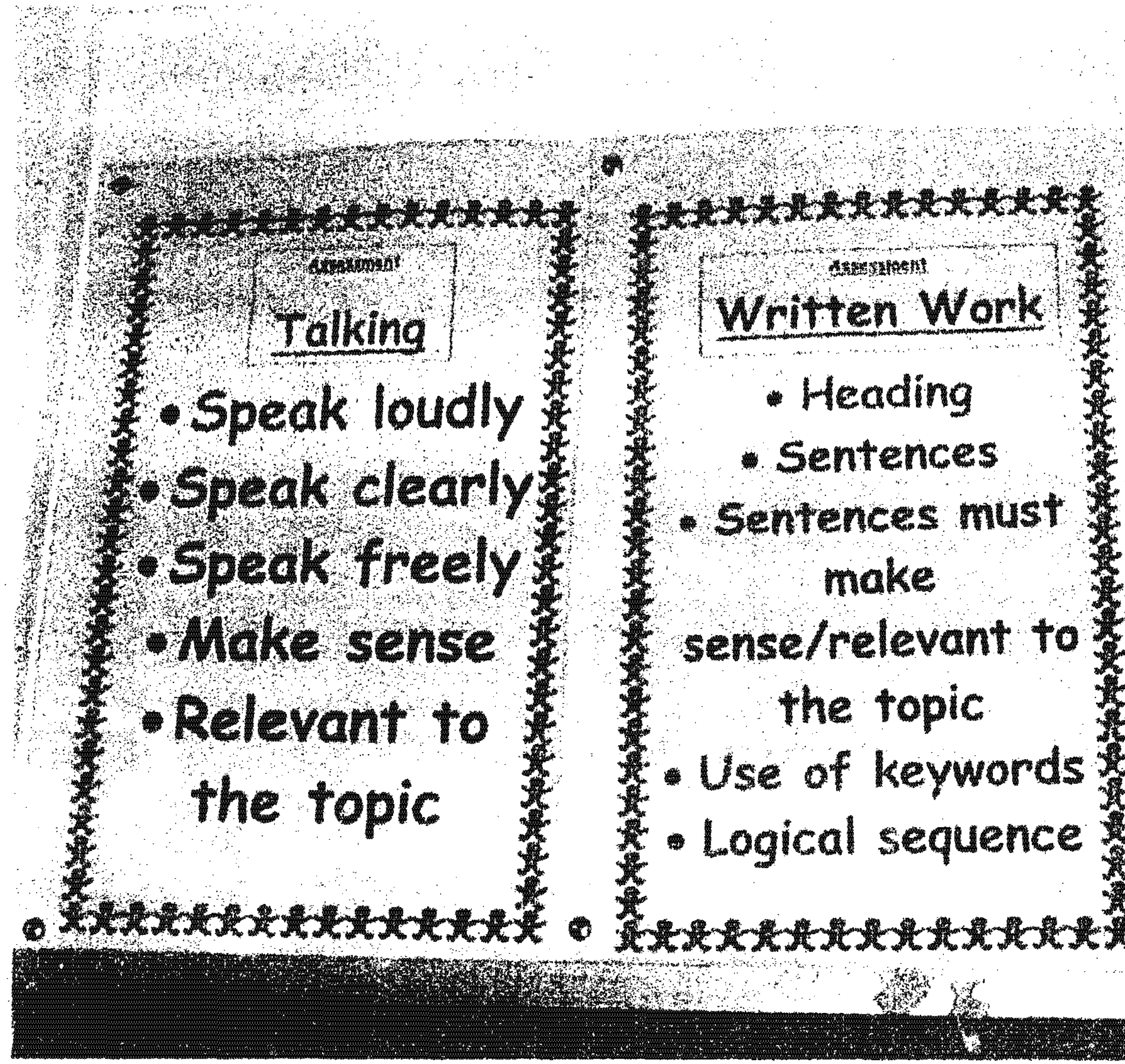
	What is happening in the picture?	Is work being done?	Does it cause any changes to take place?
1	Boy is eating	Yes	Yes
2	The child is kicking the ball	Yes	Yes
3	The bicycle is moving	Yes	Yes
4	Food is boiling	Yes	Yes

CONCLUSION:
1. **Energy makes** things happen.
2. **Energy makes** things work.
3. **Energy makes** things change.



Page 180
Plate 8 Class rules for behaviour developed with learners and displayed on classroom wall.
Class C

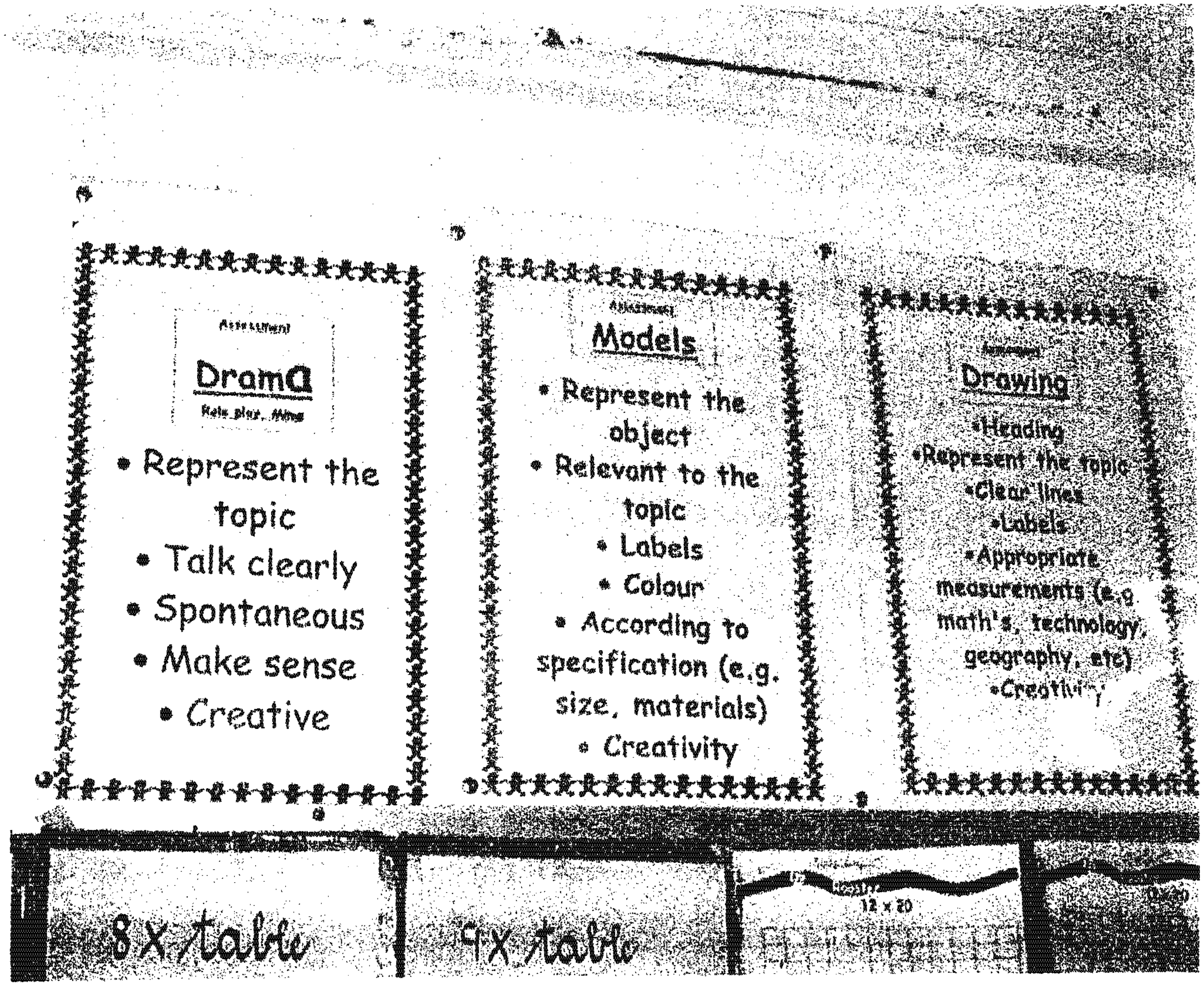
Page 181
Plate 9a Generic criteria for different forms of communication.
Class A



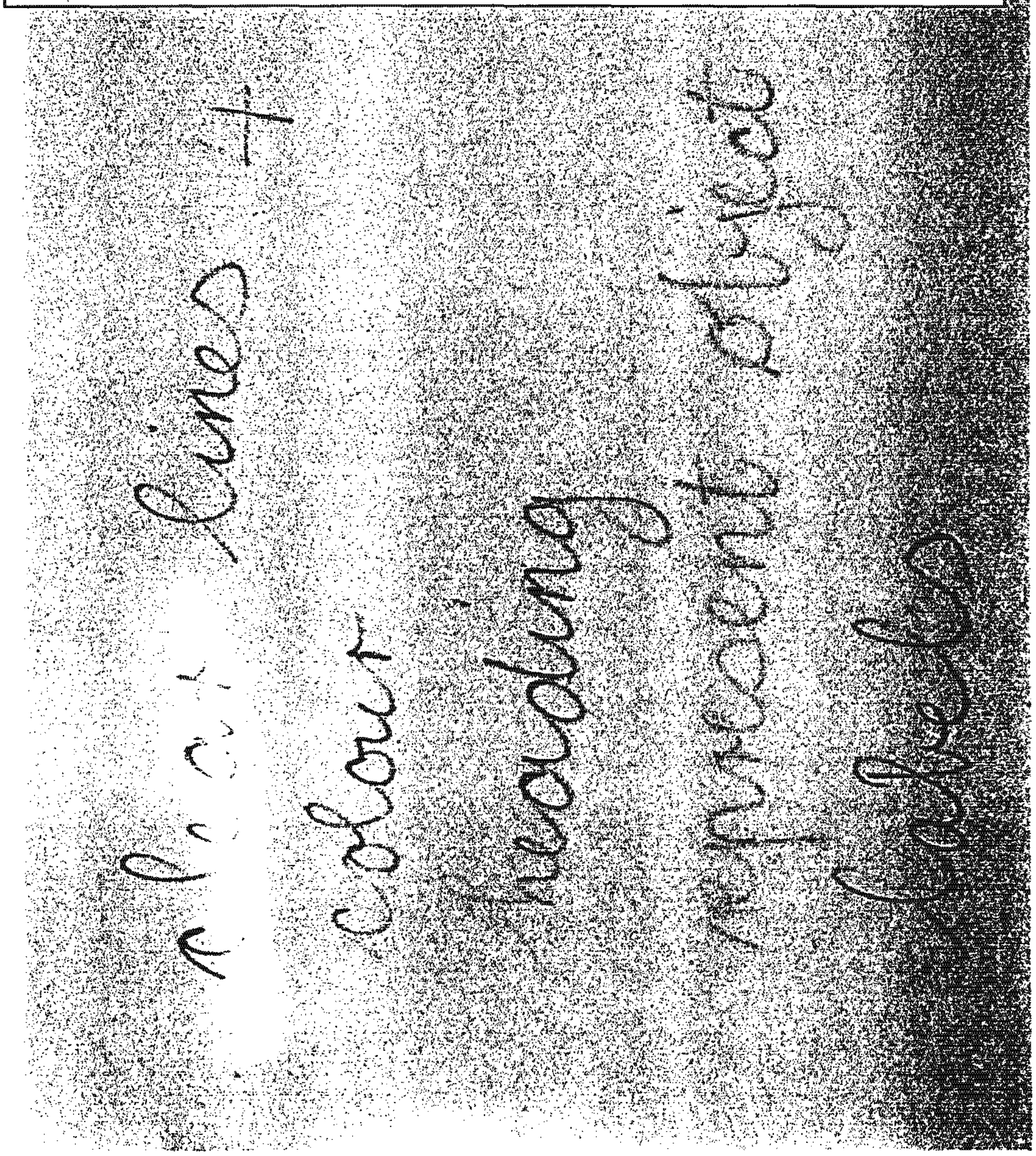
Page 182

Plate 9b Generic criteria for different forms of communication. Displayed on classroom walls

Class A



Page 183
Plate 9c Criteria written on chalkboard
Class A



Page 184
Plate 10a Self assessment sheet showing teacher's acceptance of partially completed work
Class C

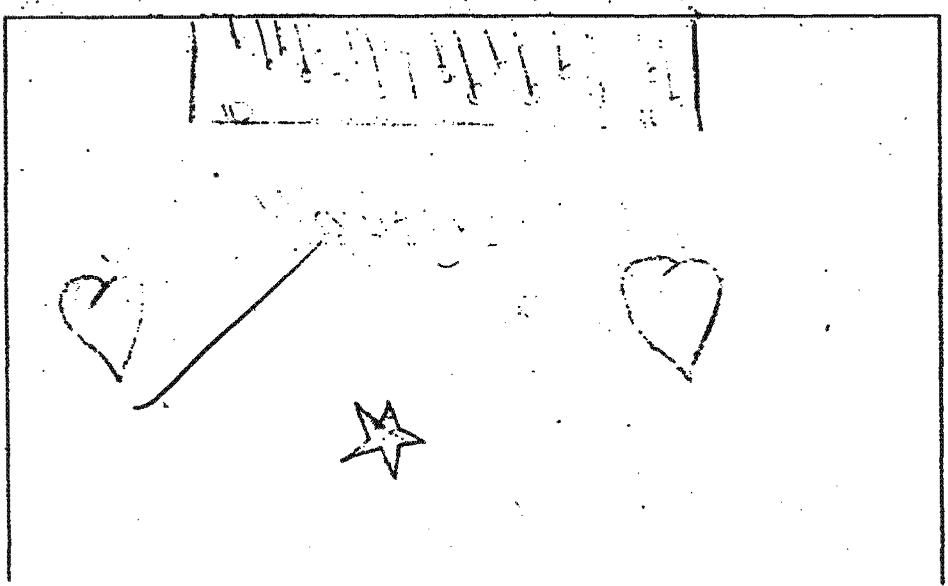
Self-assessment – PO 9

What did I learn?
I learned a lot about Static electricity ....
....
....

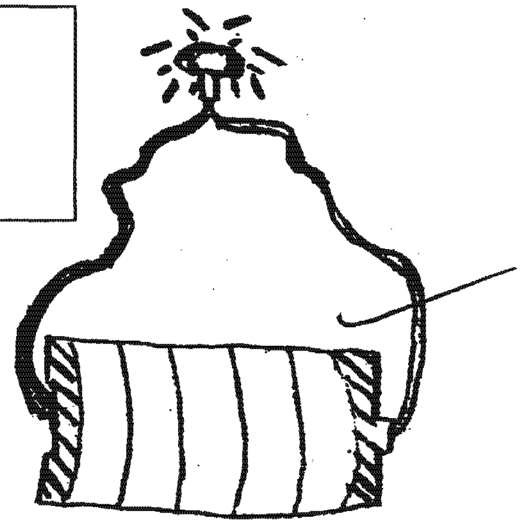
I really liked it when we ....
....
....

I want to find out more about ....
....
....

~~**This is a drawing of what I liked the best.**~~



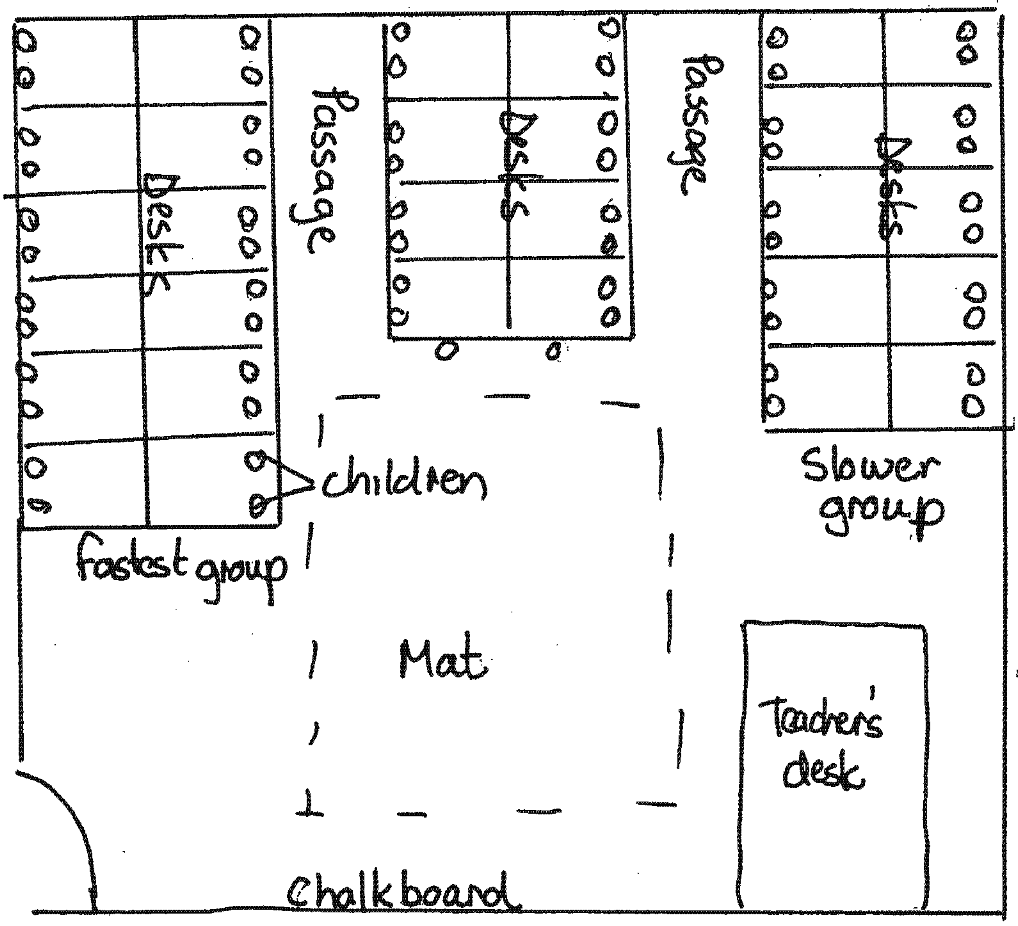
Page 185
Plate 10b Teacher accepts learner's partially completed work
Class C



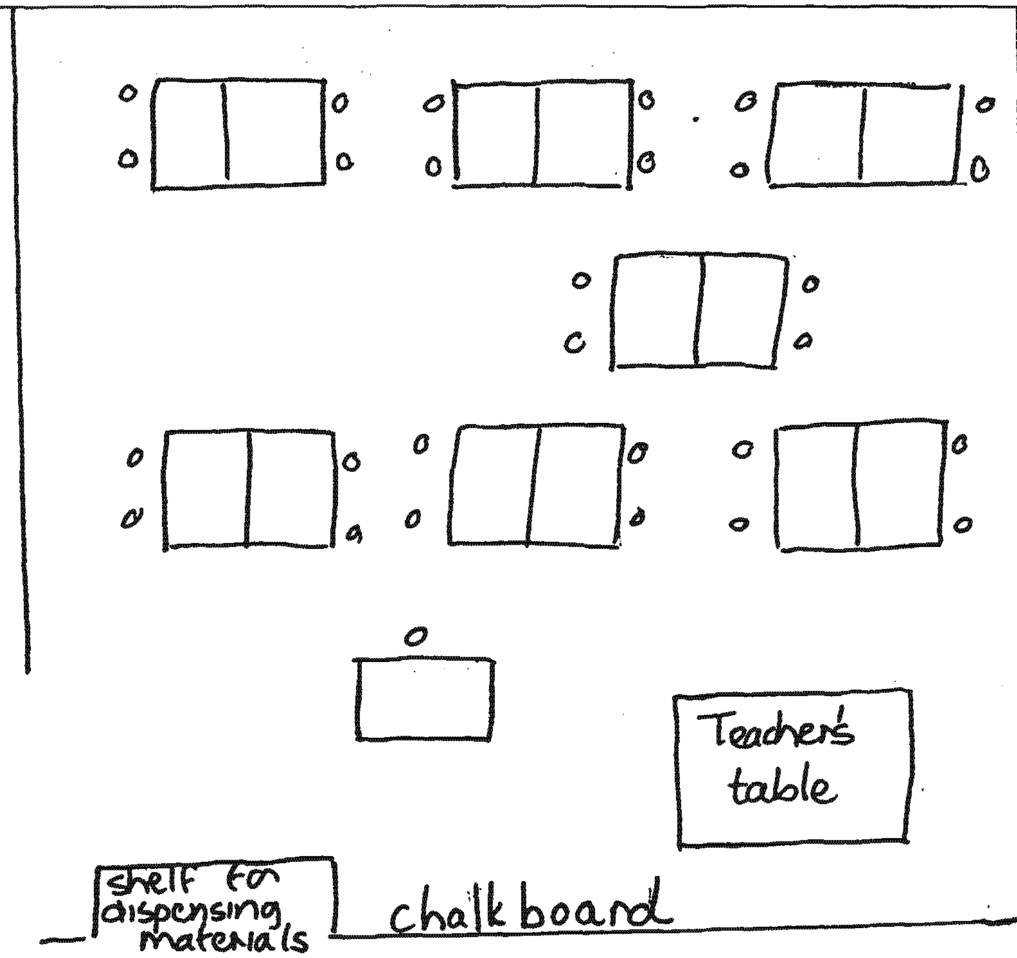
No labels

(3)

Page 186
Plate 11 Seating arrangements
Class A



Page 187
Plate 12 Seating arrangements
Class C



Self-assessment

Page 188
Plate 13 Self assessment learner response. Class C

What did I learn?

I learned a lot about static electricity.

I really liked it when we wher talking

I want to find out more about static electcicity.

This is a drawing of what I liked the best.

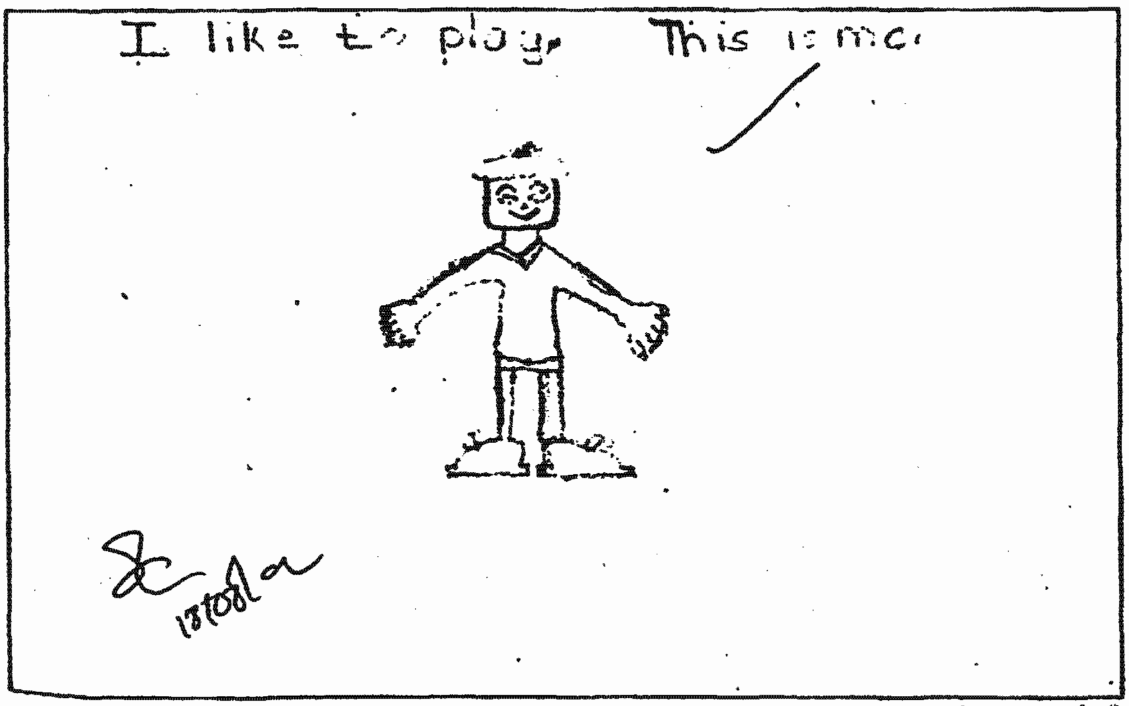


Plate 14

Class A The learner writes about how to make the light bulb light up

3 Write a paragraph to explain how you made the bulb light up.
Remember to write a heading for your paragraph.

How I made the bulb light up

Today in class I made a bulb light up. This is how I made it.

To begin with I connected the first wire to the positive end of the cell. ✓

Then I connected the other end of the wire to the bottom part of the bulb. ✓

Thereafter I connected the second wires to the side of the bulb. ✓

Finally the other end of the wire I connected to the negative part of the cell. ✓ sp

criteria
make sense gr 4 | 4
correct info 4 | 4
Past tense 4 | 4
spelling 4 | 3
punctuation 4 4

19

(B)

Plate 15
Class A

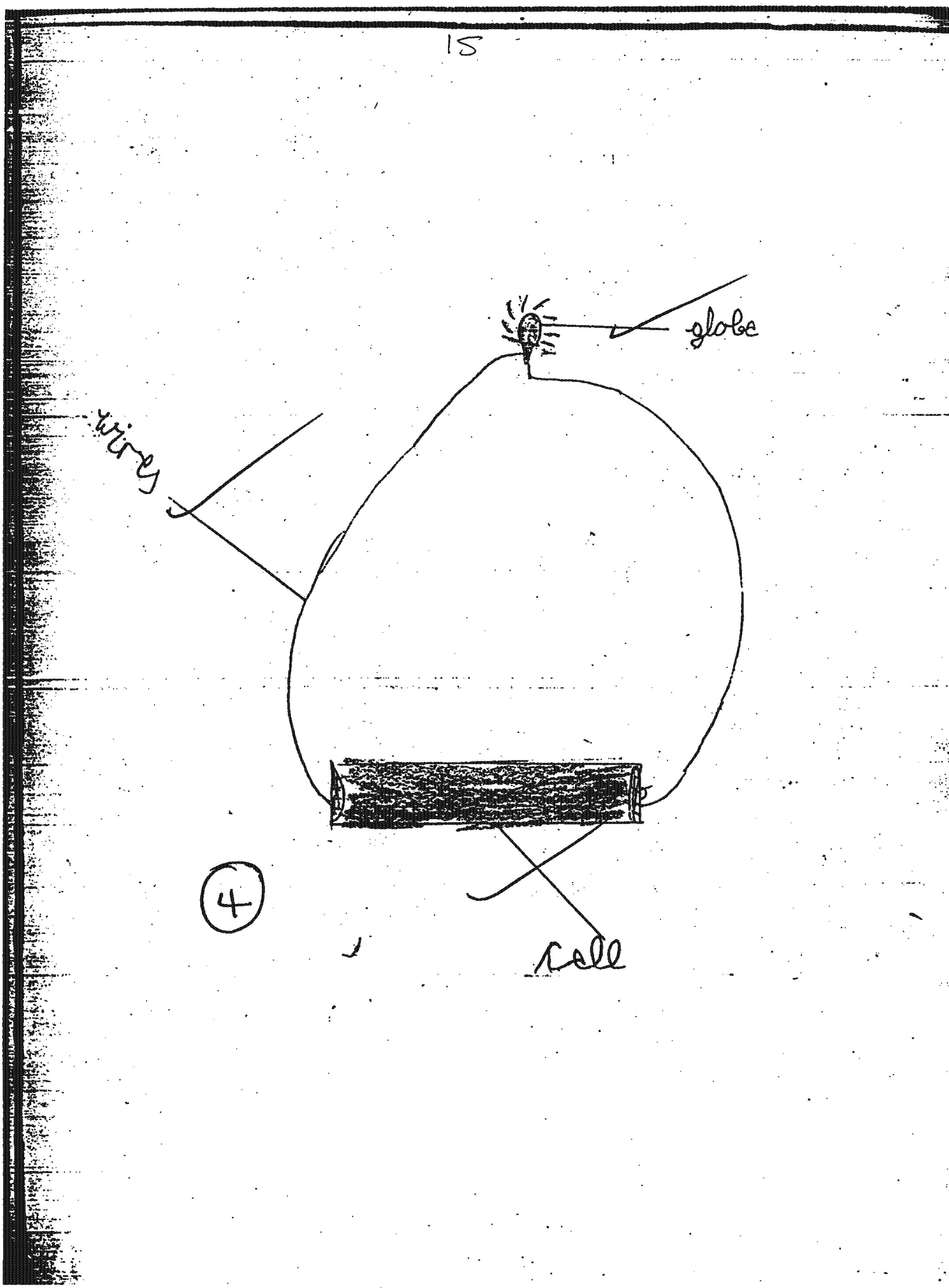


Plate 16
Class A

3 Write a paragraph to explain how you made the bulb light up.
Remember to write a heading for your paragraph.

How I made the bulb light up

Today in class I made a bulb light up. This is how I made it.

To begin with I connected the first wire to the positive end of the cell. ✓

Then I connected the other end of the wire to the bottom end of the bulb. ✓

Thereafter the second wire was connected to the side of the bulb. ✓

Finally the other end of the wire was connected to the negative end of the cell. ✓ gr

Criteria

Make sense of 4		3
collect information	4	4
past tense	4	4
spelling	4	4
punctuation	4	4
total	20	19

(5)

Plate 17
Class A

Who or what is using energy?	Where does the energy come from?	What does the energy do?
the kettle	From the gas. ✓	It boils the water. ✓
the iron	From the coal st ^ove	It warmin the iron. (warms) ✓
the lamp	From the oil. ✓	It gives heat and ligh
the radio	From the batteri ^les	It makes the radio work.
the fire	From the wood.	It gives heat and light.

3 Complete the sentences below?

(a) The kettle gets energ from gas to boil the water.

(b) The iron gets warm from the coal stove. ✓

(c) The lamp gets warm from the oil that is in it.

(d) The radio gives sound off because the batteri let it work.

(e) The fire burns because of the wood and it gives heat and light.

17/20

Plate 18
Class A

Mining in South Africa

	I think	I know
1	What do we find in mines? and Diamonds. Gold, Silver, platinum	We find iron, copper, gold and diamonds.
2	How many parts does a mine have? Six.	A mine has two parts
3	Is mining hard work? Yes.	Mining work is hard.
4	Why do you think a miner wears a helmet on his head? For safty	The helmet protects thier heads.
5	Where are the minerals found? underground	Minerals are found in rocks.
6	Are minerals useful to people? Yes.	Minerals are very useful people.
7	Name two minerals found in mines. copper and coal	It is iron and copper
8	Rocks can fall Name two dangers when working in mines they can drown.	Rocks can fall and they can drown.

10 + 9 + 7 + 2 = 28/30 excellent!

Types of Energy
26 July 2002

(4)

Heat energy

a heat energy is shown in homes fire
b heat energy is found in homes. in a fireplace
c Warm up people homes or stores.

Electrical energy

a electrical energy is ~~shown~~ used ~~on~~ by televitions
b electrical energy is found in homes and stores.
c electrical energy is able to make sound stove work

Movement energy

a movement energy is ~~found~~ shown soccer field.
b movement energy is found tennis court.
c movement energy is able to move.

} who or what moves?

Stored energy

a. stored energy is shown by people.
b. Stored energy is found in your body.
c stored energy can be used for running.

Sound energy

a sound energy is ~~shown~~ heared ~~there~~ on a radio
b sound energy is found in homes.
c sound energy is used by people.

Light energy

a light energy is shown in homes like light bulb.
b light energy is found in homes to light up a room.

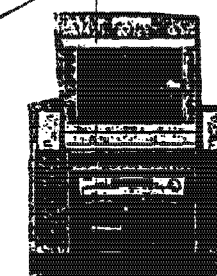
Heat energy

Movement energy

Sound energy

Light energy

Electrical energy



Stored energy

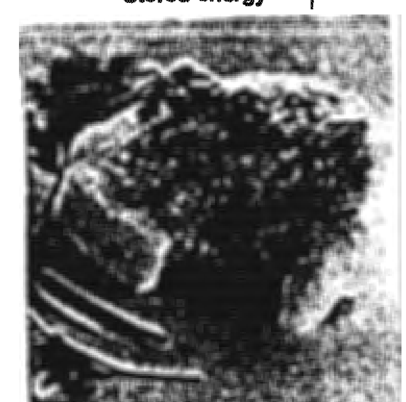


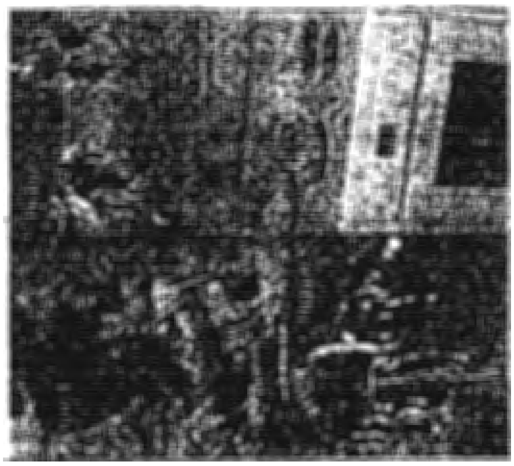
Plate 19
Class B

Plate 20
Class B

CONCEPT: What is energy?

SKILLS: Examine, Compare

ACTIVITY:
1. Study the pictures and complete the table below.
2. Compare what you have written with what other members in your group have.



	What is happening in the picture?	Is work being done?	Does it cause any changes to take place?
1	The child is eating	yes	yes
2	The children are fishing	yes	yes
3	They are riding bicycles	yes	yes
4	Food is cooking	yes	yes

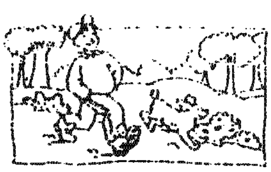
CONCLUSION:
1. Energy makes things work.
2. Energy makes things change.
3. Energy makes things happen.

Date: 29 July 2000

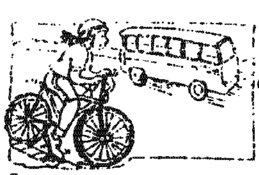
Energy is needed for different things

1. Look at the five pictures below. Choose the correct sentence from this list to write on the line below each picture.
   - Energy is needed to move something or make something move faster
   - Energy is needed to change the shape of things.
   - Energy is needed to heat things
   - Energy is needed to lift things.
   - All living things need energy to stay alive, grow and be active

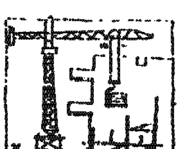
(4)



All living things need energy to stay alive, grow and be active



Energy is needed to move something or make something move faster



Energy is needed to lift things

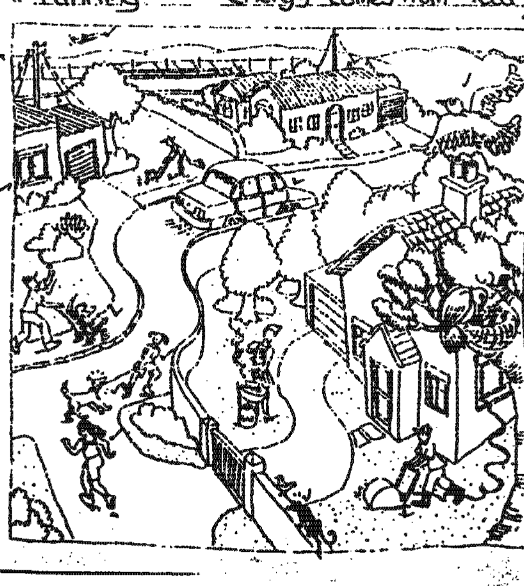
Energy is needed to heat things

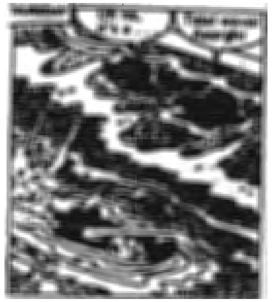
Energy is needed to change the shape of things.

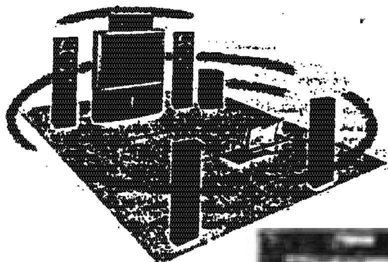
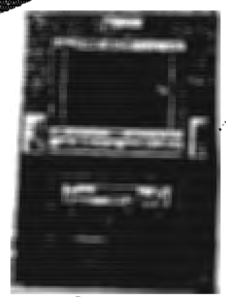
Where does energy come from?

1. Look at the picture on this page. Find all the things that are using energy. Put a small ✔ next to each one.
2. Choose any four of the things you ticked. Name them. Next to each one write where you think the energy that is being used comes from.

a. car — energy comes from petrol
b. outdoor cooking — energy comes from gas
c. lawnmower — energy comes from electricity
d. running — energy comes from food that is stored in



5 August 2002

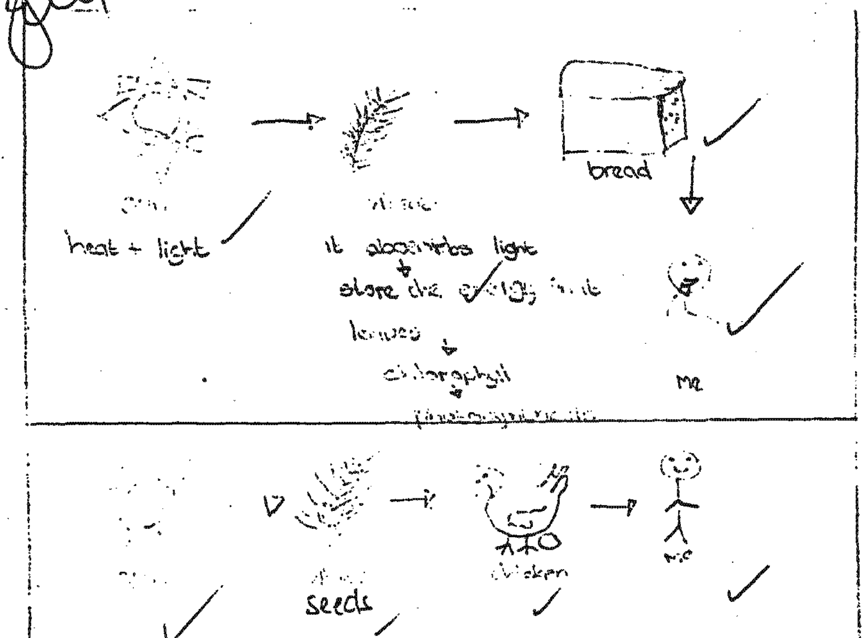
The different forms of energy my body uses.

Eating my lunch.	movement energy is being used	Protiens for muscles carbonyhrates for energy
doing my home-work	mental energy is being used.	fruit, meat, bread
Cleaning the house.	kintcic energy is being used.	fish, veg
going to play outside	movement energy is being used	carbehydrats
running around while playing	kintcic energy is being used.	onions, potatoes, tomatos.

Where does my energy come from originally

6 August 2002

(1) Green plants take energy from the sun to make food.
(2) Plabts are the only living orgnisms that can make their ownfood.
(3) Energy is stored inside the food we eat.
(4) We get this energy when we eat food.
(5) Energy is tranoferred from one living thing to anther in a sequeuce known as an energy chain.



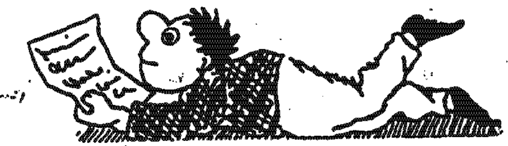


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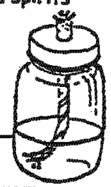
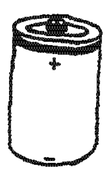
Plate 22
Class B

Learner Task Card

To photocopy for
Activity 4

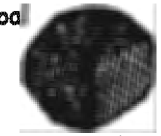
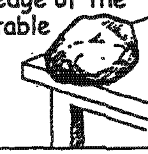
Getting stored energy out

1. There is energy stored in each of these energy sources in the boxes below.
2. Try to do something to get the energy out of each source, and complete the table below:

This is where the energy was stored	What we did to get the energy out	This is the energy we get out	The energy changes that take place
Candle wax 	I burned it	Heat and light energy	
Peanut 	I eat it	Stored energy	Stored energy (Stay the same) movement energy
Methylated spirits  Spirits	I burned it	Heat and light energy	Potential energy changed into heat and light.
Battery 	I put it in a torch and connect it to a circuit	light energy	Potential energy changed into light energy
Stretched elastic band 	I streach the elastic band to change its shape (let it go)	movement energy.	Potential energy changed into movement energy.
Wood 	I burned it to make fire	heat and light energy	Potential energy changed into heat and light.

To photocopy for
Activity 4

Learner Task Card

Coal 	I burned it	heat and light energy	Potential energy changed into heat and light.
A stone on the edge of the table 	I must push it off the table.	movement energy sound energy	Potential energy changed into sound and movement energy.

2. Write sentences to tell what you did to get the energy out of each thing e.g. There was stored energy in the candle wax. I burned the wax to get heat and light energy from it.

(a) There was stored energy in the peanut I made the peanut to get the stored energy out of it.

(b) There was stored energy in the methylated spirits. I burned it to get heat and light energy out of it.

(c) There was stored energy in the battery and to get light energy you put it in a torch.

(d) There was stored energy when I stretch the elastic band to change it's shape movement energy

(e) There was stored energy In the wood I burned it to get light and heat energy.

(f) There was stored energy In the coal I burned it to get heat and light energy.

(g) There was stored energy in the stone I pushed it to get movement energy.

4

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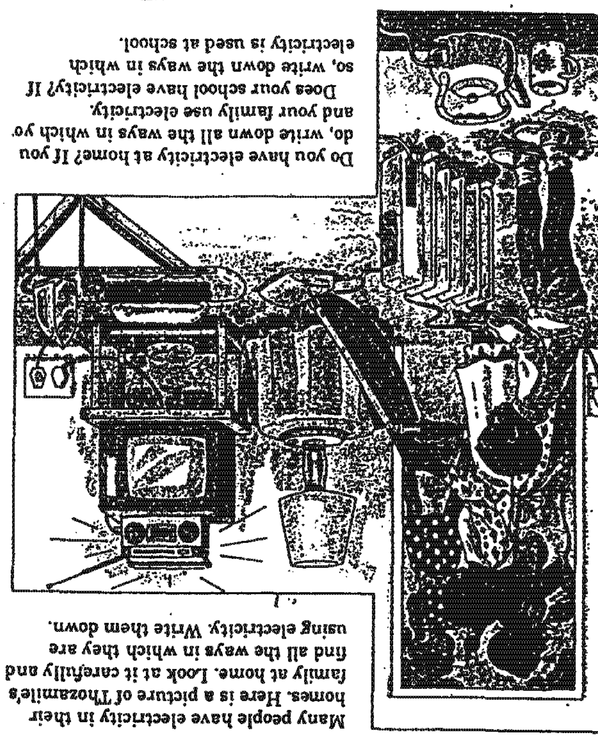
Plate 23
Class B

Plate 24
Class B

Is electricity useful?

Many people have electricity in their homes. Here is a picture of Thozamile's family at home. Look at it carefully and find all the ways in which they are using electricity. Write them down.



Do you have electricity at home? If you do, write down all the ways in which yo and your family use electricity.

Does your school have electricity? If so, write down the ways in which electricity is used at school.

There are many people who don't have electricity at home. Leila's family has no electricity. They must find other ways to do the things that electricity does in Thozamile's home. Look at this picture of Leila's family and write down all the things they use instead of electricity.

Did you know?

20 million people in South Africa don't have electricity in their homes.

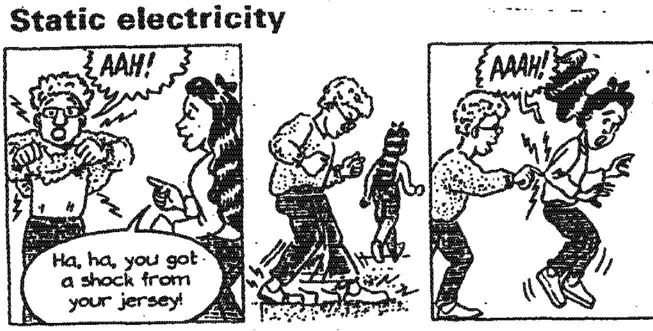
Is your home without electricity? If it is, write down what you use instead.

Which do you think is better — to be with or without electricity? Discuss this question with three friends from your class. Then tell the other people in the class what you think.

Find out -

Why do some people where you live have electricity, and some not?

Static electricity



6

Talk to a partner about this comic. Why do we sometimes get shocks when we take our jerseys off or when we rub some carpets while wearing rubber shoes? The following activity will help you to understand what happens.

Making an electric charge

ou will need
• a plastic ruler (or pen)
• a piece of paper

5

INSTRUCTIONS

(1) Rub the ruler against your clothes gather small pecss of paper and put the ruler against the small piece of paper and the paper will attract to the rulr

EXPLANATION

FILL IN THE MISSING WORDS.

Picking up pieces of paper using electric charges

When some objects are rubbed, they get an electric charge on them. The objects can then attract other objects. We saw this when we rubbed the plastic ruler. It attracted the paper and hair. We call the electric charge that is made when we rub something static electricity.

Plate 25
Class B

Information sheet for

How coal is made in the Earth

Coal is a hard, black rock. For hundreds of years people have burned coal to keep themselves warm. It takes millions of years to make coal.

Millions of years ago there was a lot of water and many trees covered the Earth. Sometimes when trees died they fell into the water. Over many years, layers of soil covered the trees and turned the wood into peat, which is soft and can be burned for fuel.

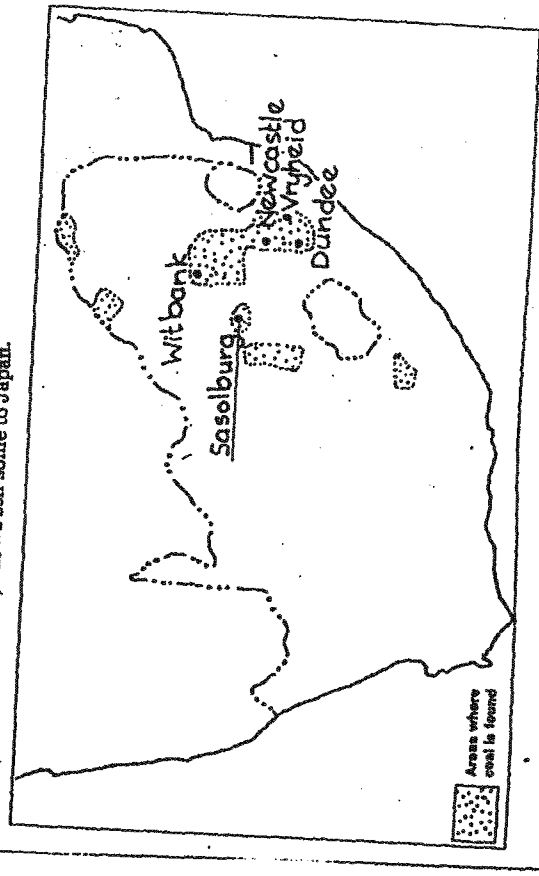
More and more layers of heavy soil on top caused more pressure so that gas and water were squeezed out of the peat. This made the peat change into a thin layer of hard coal or into oil. The Earth takes millions of years to make the coal. This coal is formed very deep under the ground and so people have to dig mines to get it out. There are many coal mines in South Africa

Using coal

Most of South Africa's coal is used in Power Stations to make electricity. There is a big factory in Sasolburg that makes coal into petrol. A special form of coal called coke helps us to make iron into steel. Tar, plastic and fertilizers also come from coal. People use coal in their homes to cook food or keep themselves warm. If we continue to use coal, the world will soon run out of it. This is a great worry and many people are looking for different types of fuel in order to save coal. The Earth's oil will be used up by the year 2030 and coal by 2085.

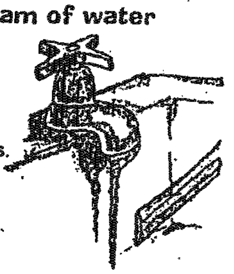
Coal in South Africa

South Africa has a lot of coal. Look at the map to see where we mine it. We use most of our coal, but we sell some to Japan.



How to attract a thin stream of water

- Open a water tap very slightly. Let a thin, smooth stream of water flow out.
- Charge a plastic ruler by rubbing it against your hair or your clothes.
- Slowly bring the ruler close to the water.

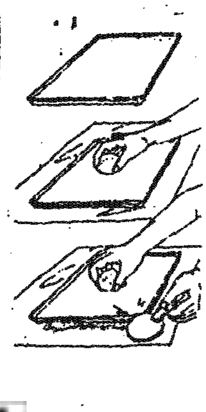


What happens? Can you explain this?

The water moves towards the ruler As a result of the static energy.

24 EXPERIMENT

1. Press a large lump of plasticine onto the middle of a very big baking tray or a small tin tray. Press it hard so that it sticks well.
2. Put the tray down on a very large, thick plastic bag. A rubbish bag will be large and thick enough. Hold the plasticine lump and rub the tray round and round on the bag.
3. Pick up the tray by the plasticine. Hold something made of metal, such as the lid of a tin, close to one corner of the tray. Hold the lid with a wooden peg, so that your hand doesn't get hurt. You'll see a big spark jump from the tray to the tin. Try to do this in a dark room so that you see the spark better.



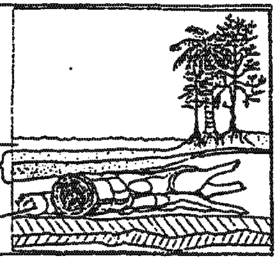
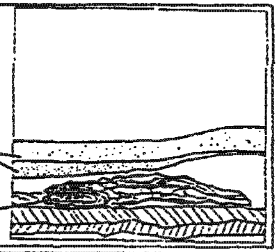
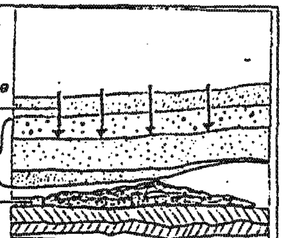
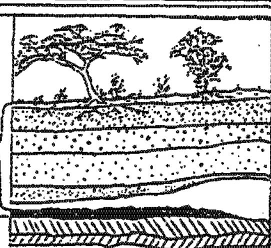
Find out

1. How do lightning conductors protect houses and buildings from lightning?
2. What can we do to protect ourselves from lightning during a storm?

1) It takes the electricity away from the building.

2) Staying away from things that uses electricity like phone's, tv, radios.

Paste the story of how coal was formed in correct sequence on to your task card.

Pictures that tell how coal was formed	Paragraphs that tell how coal was formed
First 	Millions of years ago the Earth's climate was wet, so many plants grew near water. When these plants died, some fell into the water. They did not rot but in time layer upon layer of sand and mud covered them.
Then 	More and more layers of sand and mud fell on top of these dead plants. They slowly became squashed plant material, which we call peat.
Next 	More and more pressure from sand and mud compressed and squashed this plant material into a harder layer. This layer is called lignite. As the compression took place gas and water were squeezed out of the dead plant material.
Finally 	Over millions of years more layers of sand and mud covered the lignite. The lignite eventually became a hard black type of a rock called coal.

Task card for
Activity 6

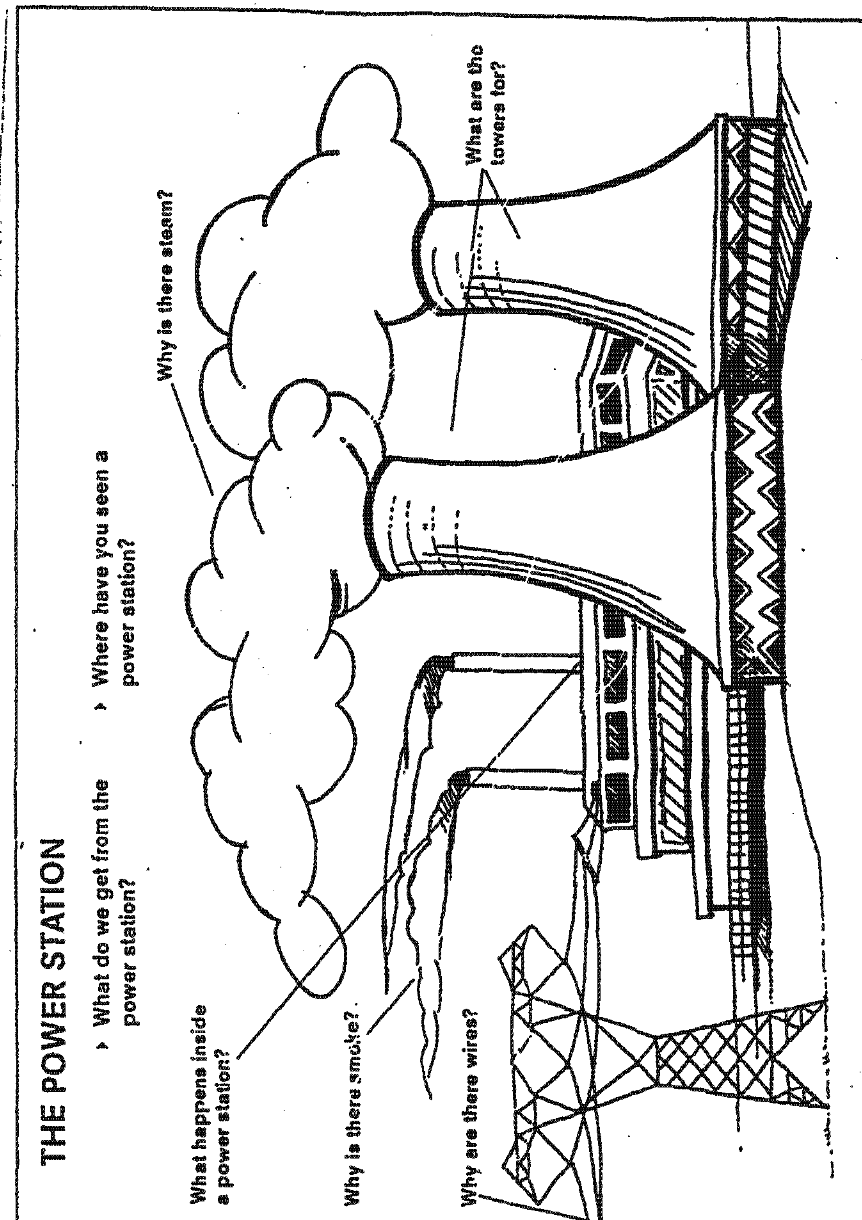


Plate 27
Class B

Explain in your own words how coal was formed.

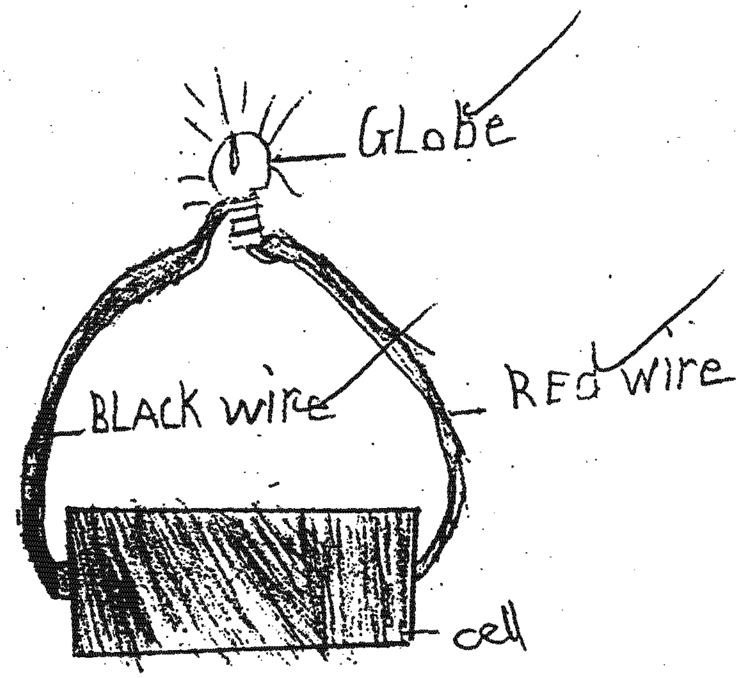
Key words – 1 millions of years
– 2 hard, black rock
– 3 trees
– 4 soil
– 5 peat
– 6 pressure
– 7 lignite
– 8 mines

It takes millions of year to form coal. The coal looks like hard black rock. Trees died and fell into the water over many years soil, mud and rock coverd the trees. More and more layers of soil covered the tree and now its called peat. All the pressure and gas gets squeezed out of the soil and the dead tree. More and more pressure and soil and mud is compressed and now is formed into a harder layer of rock called lignite. Tone mines are diged to find coal.

(4)

[illegible]

Plate 28
Class C



(4)

Plate 29
Class C

40

ELECTRICAL ENERGY

DATE 7 August 2002

1. What made the globe light up?
The electricity in the cell

2. How many wires do you need to connect the cell to the globe?
two wires

3. Electricity flows from the cell through the wires to the globe and back through the second wires to the cell.

4. Draw and label your experiment.

JC 12/08/02

Plate 30
Class C

Self-assessment – PO 9

What did I learn?

I learned a lot about envy I learned you get the Sowces of energy the forms of energy and a nother name for Sowces fuels.

I really liked it when we rubed the ruler against your jersey that was when we rubed the ruler under your arm and toilet paper sticks

I want to find out more about static electicity it looks like it is cool

This is a drawing of what I liked the best.

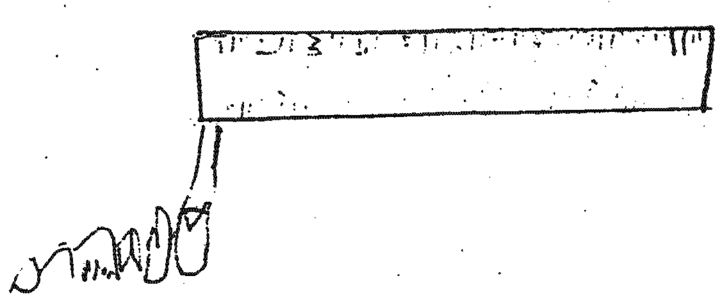


Plate 31
Class C

Static Electricity 12 August 2002

1 How is static electricity formed?
by rubbing objects together
2 Name one object that uses static electicity to make it work.
dynamo
3 What is meant by the word: FRICTION?
rubbing
4 Write down the meaning of the words below:
energy: the ability to do work
force: a push or a pull
friction: rubbing
gravity: the force that pull everything towards the earth.
lubricant: substance needed to oil or grease something so that it moves smoothly.
magnetism: energy from a magnet to attract certain elements.
work: using energy to do something.

good

6/20/8/02

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