

**APPRENTICING LEARNERS IN THE CONTEXT OF THE GRADE 10
PHYSICAL SCIENCE CLASSROOM**

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THE MAIN BODY OF THE REPORT

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ABSTRACT

The number of African learners who participate and succeed in physical science is recognized to be ‘disturbingly low’. One of the factors attributed to the low levels of enrolment and performance in physical science is language. In this study, teaching and learning through the language of science is examined in the context of the bilingual classroom. A model of analysis is constructed that (1) extends the notion of the language of science to include the mathematical and visual ‘languages’ of science, (2) takes recognition of the manner in which language, content, and values and beliefs construct the science learner, and (3) moves beyond the characterization of teaching and learning according to the dichotomy of the ‘traditional’/ the ‘progressive’. The model of analysis draws upon the central concepts of a sociocultural model of pedagogy, namely the ‘developmental model’. In addition, the model of analysis makes use of Systemic Functional Linguistics to examine teaching and learning at the micro level of classroom interaction. This study reveals the complex nature in which the language, content, and values and beliefs change as a lesson unfolds: teaching and learning through the language of science has been shown in these classrooms to be marked by features of both a ‘traditional’ and a ‘progressive’ model – each of which appears to serve different functions in the overall construction of the science learner. In addition, this study begins to uncover how a ‘successful’ teacher equips his/ her learners in the context of the bilingual physical science classroom: teaching and learning through the language of science has been shown in these classrooms to incorporate complex and varied strategies that depend upon choices made by both the teacher and learners. These findings

substantiate the need to understand the challenges teachers and learners face in the bilingual physical science classroom in ways that acknowledge the complexity of the teaching and learning process.

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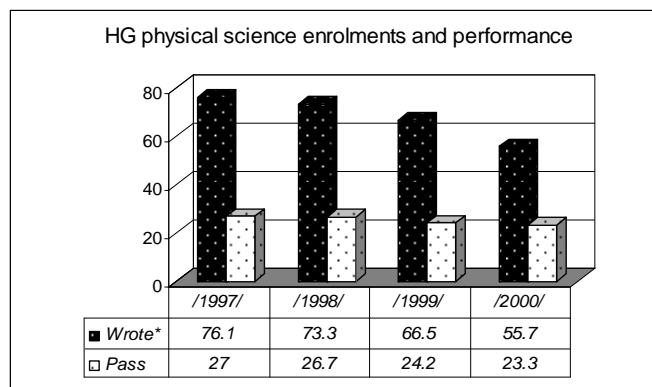
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CHAPTER 1

INTRODUCTION

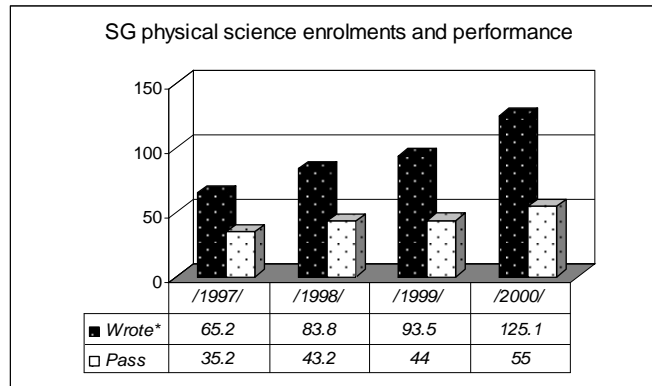
In 1997, shortly after the first democratic elections in South Africa, a new progressive curriculum was introduced. Curriculum 2005, as it was called, was intended to create a deliberate break with South Africa's apartheid past, as well as to improve the quality of teaching and learning in schools. It was a state of the art curriculum drawing on current practice in overseas countries such as Australia, Britain and Canada. In addition, it was outcomes-based, learner-centered and advocated integration as one of its key design principles.

Despite the good intentions of the new curriculum, problems remain with the teaching and learning of physical science in South African schools. This is evident from the low levels of enrolment and performance in the Senior Certificate examination, which marks the move from the Further Education and Training (FET) Band to tertiary education in South Africa. The enrolment and performance of learners in physical science for the Senior Certificate examination during the period 1997 to 2000 are shown in *Figure 1-I* and *Figure 1-II* below and on the following page for higher and standard grade, respectively.



* Total number of candidates (x1000)

Figure 1-I The number of enrolments and performance of learners for physical science on higher grade (HG) during the period 1997 to 2000 (South Africa, 2001:10)



* Total number of candidates (x1000)

Figure 1-II The number of enrolments and performance of learners for physical science on standard grade (SG) during the period 1997 to 2000 (South Africa, 2001:11)

It is evident from *Figure 1-I* and *Figure 1-II* that during the period 1997 to 2000 the number of learners enrolled to do physical science on the higher grade decreased and the number of learners on the standard grade increased. In addition, it is evident that whereas there was an increase in the number of learners who passed physical science on the standard grade, the number of learners who passed on the higher grade remained much the same (South Africa, 2001).

The number of African learners who participate and succeed in physical science is recognized in particular to be “disturbingly low” (Masehela, 2005; Muller, 2000; and South Africa, 2001:12). For example, an analysis of the 2000 Senior Certificate results indicates that out of a total population of over 400 000 learners, only 33 657 wrote physical science on higher grade and 77 680 on standard grade. Furthermore, of these learners only 5136 and 32 874 passed on the higher grade and standard grade, respectively (South Africa, 2001:12).

Research has been carried out to try to account for the low levels of enrolment and performance of African learners in physical science: language, in particular teaching and learning through the medium of English, has been identified as a significant factor

(Howie, 2001; Probyn, 2004; Rollnick, 2000; South Africa, 2004; and Taylor and Vinjevold, 1999b).

In referring to the poor performance of South African learners in the Third International Mathematics and Science Study (TIMSS), Howie (2000:2) states:

...the majority of South African pupils cannot communicate their scientific conclusions in the languages used for the test (i.e. English and Afrikaans which were the medium of instruction and are the languages currently used for matriculation examinations). In particular, pupils who study mathematics and science in their second language tend to have difficulty articulating their answers to open-ended questions and apparently had trouble comprehending several of the questions.

In referring to the poor performance of South African learners in the Senior Certificate examination, the 'Summary Report on the Evaluation of the Senior Certificate Examination' by Umalusi (South Africa, 2004:4) states:

In 1998 the Minister of Education appointed a research team to investigate the language issue, on the assumption that learners who write the Senior Certificate examination in a language that is not their mother tongue are seriously disadvantaged. The team concluded that language was a major factor contributing to poor performance by such learners in the Senior Certificate.

And in addressing the need for improvements in teaching and learning physical science through the medium of English, the 'National Strategy for Mathematics, Science and Technology Education and Training' (South Africa, 2001:16-17) states:

Language policy matters are important in the learning and teaching of mathematics and science...Although language problems reflect insufficient conceptual understanding, difficulties associated with the learning and teaching of mathematics and science are also associated with lack of proficiency in the medium of instruction. It is therefore important to strengthen the teaching of English second language.

Having recently qualified as an English Second Language (ESL) and Chemistry teacher in Melbourne, Australia, and having taught English and science in the context of the

bilingual classroom over the past five years in South Africa, Australia and Taiwan, I was interested to examine more closely teaching and learning science in the context of the bilingual classroom and to make a contribution towards our understanding of this process.

After conducting a preliminary study over a period of two weeks at four different schools in the Eastern Cape, South Africa, and after reading more widely in the field of language and science, the following issues to do with teaching and learning through the language of science became apparent.

Firstly, that in the science classroom in particular, there are multiple ways of making meaning: verbal (and written) language, mathematics, pictures, and values and beliefs to do with science (Wells, 1999).

Secondly, that it was not possible to separate the ‘content’ of science from the ‘language’ of science: if learners were encouraged to share anecdotal information in the science classroom, the language was different to that which was used if learners were asked to define a scientific term; if learners were encouraged to contribute their prior knowledge to do with the topic at the beginning of a unit of work, the language was different to that which was used when learners answered a question towards the end, having learnt, for example, several new terms.

And thirdly, that the interplay between language, content, values and beliefs was somewhat different in the various science classrooms observed. The learners were acquiring slightly different understandings of what it meant to be a science learner, suggesting that the construction of the science learner would be a significant focus of the study (Christie, 2002). In South Africa, current curriculum policy emphasizes “the kind of learner” (South Africa, 2003c:5) that is envisaged: in a time where a deliberate break from the apartheid regime has been made through the implementation of new curriculum policies, an emphasis has been placed on the need to foster learners who are critical

thinkers, problem solvers, accountable, and operate in a multilingual environment in which there is an appreciation for the value of human difference (South Africa, 2000a).

It was therefore important to use a model of analysis to understand teaching and learning through the language of science that included not only the verbal (and written) language of science but mathematical and visual literacies, as well as values and beliefs to do with science. In addition, it was important to use a model of analysis that revealed how language, content, values and beliefs play a role in the construction of the science learner (Christie, 2002).

It was also important to use a model of analysis which recognizes that developing a learner's knowledge of science, and developing their knowledge of the language that constructs and communicates that knowledge, are one and the same thing (Unsworth, 1998:200). For example, in this study it is shown that the language through which teaching and learning takes place is not the same when the knowledge that is constructed and communicated is of the 'everyday' in comparison to the 'scientific', and when the knowledge is essentially of the present in comparison to being marked by a sense of progression.

As a result, a model of analysis was constructed that incorporated these various ideas to do with teaching and learning through the language of science. The model of analysis draws largely upon the central concepts of a sociocultural model of pedagogy, namely the 'developmental model' (Christie, 2002), which places emphasis on an individual being embedded (apprenticed) as a member of a social practice (Gee, 1996). Consequently, the study focuses on the learners' induction into science. In addition, as the study is interested in how language, content, and values and beliefs construct the science learner, it focuses on the construction of the 'ideal pedagogic subject position' (Christie, 2002). The research question for the study is thus as follows: "How are these learners apprenticed to be science learners and what is the 'ideal pedagogic subject position'?"

The research question was broad, allowing for greater focus to emerge as the research progressed. An issue that emerged was the tension between ‘traditional’ and ‘progressive’ modes of teaching. Muller (2000: 105) claims that during this time of curriculum reform a ‘progressive’ and a ‘traditional’ model of pedagogy are “jostling for dominance”. This has not been helpful to teachers for understanding what constitutes ‘good’ teaching practice: ‘teacher-centered’ practices, such as whole-class teaching, have been viewed as traditional, and to be abandoned in favour of ‘learner-centered’ practices, such as groupwork (Probyn, 2004).

It was therefore important to incorporate in the model of analysis means to understand teaching and learning through the language of science that enabled teachers in the current context of South Africa to be reflective and reflexive practitioners, and that did not undermine existing good practice. In other words, the model of analysis needed to go beyond understanding teaching and learning in terms of the dichotomy of a ‘traditional’/ ‘progressive’ model of pedagogy.

As a result, a model of analysis was constructed that, firstly, examined teaching and learning through the language of science in the context of whole-class teaching: a mode of teaching and learning generally viewed as ‘traditional’.

The choice of ‘whole-class teaching’ as a context was made, in part, to understand teaching and learning in ways that went beyond the characterization of strategies teachers draw upon in practice according to the dichotomy of the ‘traditional’/ ‘progressive’, and due to the “somewhat undifferentiated manner” (Wells, 1999:168) in which whole-class teaching has been treated in the past.

Secondly, a model of analysis was constructed that examined teaching and learning at the micro level of classroom interaction: four texts were selected and analyzed in terms of the whole text using Systemic Functional Linguistics (SFL) (Halliday, 1994).

SFL underpins the research design of this study:

- (1) Firstly, in terms of the ‘choices’ teachers and learners have to do with language, content, and values and beliefs;
- (2) Secondly, in terms of the notion of genre theory – in this study whole-class teaching – used as a “principled basis” (Christie, 2002:22) for the selection of data;
- (3) And thirdly, in terms of the ‘metafunctional’ organization of language used to understand the complex “system of doings” (Lemke, 1995:93) that operate through the language of science, and that constitute the community of the science classroom.

The choice of SFL was made, in part, to enable “great rigour” (Morais and Neves, 2001:215) to be applied in the analysis and interpretation of the data. The need for “great rigour” to be applied is recognized to be important if the researcher is to move beyond the characterization of teaching and learning in terms of the dichotomy of the ‘traditional’/ ‘progressive’ (Morais and Neves, 2001).

Lastly, although several grades were observed during the preliminary study I chose to focus upon grade 10 because Curriculum 2005 is being implemented in grade 10 for the first time this year in 2006. In addition, although several teachers were observed during the preliminary study I chose to focus upon two successful teachers, one of whom had been selected by the Provincial Department of Education to receive additional training so that he could equip the science teachers in his district with regards to implementing Curriculum 2005.

Given the amount of time that I had in order to conduct the study, I decided that most could be learnt from examining how a *successful* teacher and his/ her learners ‘talk’ (Lemke, 1993) science bearing in mind the challenges that face teachers and learners in South Africa, in particular, ‘talking’ science in a language that is not the learners’ home language.

A brief outline of the thesis follows:

In the Literature Review, Chapter 2, the theoretical framework that underpins this study is provided. The Literature Review is subdivided into three sections, 2.1 – 2.3, according to the notion of classroom work as social practice, classroom work as structured experience, and classroom work and the three types of meaning (Halliday, 1994).

In Section 2.1 – Classroom Work as Social Practice – (1) the central concepts of the developmental model; (2) the role the central concepts of the developmental model play in the construction of an ‘ideal pedagogic subject position’; and (3) the manner in which the central concepts of the developmental model are addressed in the Revised National Curriculum Statement (RNCS) are discussed.

In Section 2.2 – Classroom Work as Structured Experience – ‘genre theory’ as a “principled basis for the selection of classroom texts for analysis and interpretation” (Christie, 2002:22) is discussed.

In Section 2.3 – Classroom Work and the Three Types of Meaning – the three distinctive features of Systemic Functional Linguistics, namely (1) the metafunctional organization of language; (2) the notion of system; and (3) the relationship between text and context, are discussed.

In the Methodology, Chapter 3, the decisions made relevant to doing research into classroom practice, as well as their possible limitations, are discussed. The Methodology is subdivided into seven sections, 3.1 – 3.7, according to the different dimensions of this study that required decisions to be made, namely:

- (1) Conducting preliminary research;
- (2) Formulating the research question;
- (3) Choosing discourse analysis as the principal mode of analysis;
- (4) Selecting the data;

- (5) Presenting the data;
- (6) Analyzing the data; and
- (7) Addressing validity threats.

Examples from the presentation, as well as the interpretation and analysis of the data, are provided.

In the Data Interpretation and Analysis, Chapter 4, I report on the analysis of the four texts selected in relation to the whole text. The Data Interpretation and Analysis is subdivided into four sections, 4.1 – 4.4, according to the four texts selected, each of which foregrounds a central concept of the developmental model. Each text is analyzed at the micro level of classroom interaction using SFL; in addition, a narrative style is adopted to contextualize the detail that is uncovered and to take the reader through the various stages of each text. A brief summary of the findings concludes each section.

Finally, conclusions from this study are drawn; these include:

- (1) What has been learnt from this study;
- (2) How the theories used have been extended for the purposes of this study;
- (3) Where the findings of this study coincide and do not coincide with the findings of previous research that has been done;
- (4) What the implications of the findings are for teachers, researchers, and teacher educators;
- (5) Practical suggestions for teachers considering these findings; and
- (6) What the limitations of the study are and where there is a need for further research to be done.

CHAPTER 2

LITERATURE REVIEW

In Chapter 2 the theoretical framework that underpins this study is explained. The overarching theoretical framework, which forms the three main sections for this chapter, is to do with classroom work as social practice, classroom work as structured experience, and classroom work as a meaning-making activity. Within this framework the central concepts of the developmental model are explained in terms of the ‘choices’ teachers and learners make in the classroom and the construction of the science learner. In addition, the notion of genre-theory and the features of Systemic Functional Linguistics are explained in terms of their use as tools for understanding classroom practice in this study.

2.1 CLASSROOM WORK AS SOCIAL PRACTICE

In this study, the central concepts of the ‘developmental model’ (Christie, 2002) are used as an analytic lens to understand the teaching and learning process in the context of the grade 10 physical science classroom. As discussed in the Introduction, the developmental model is a sociocultural model of education.

Sociocultural theory proposes that cooperative human activity is only possible because individuals live and grow up within larger scale social organizations or institutions. These include, amongst others, the family, the school, the university, the corporation, the city, the global economy. (Lemke, n.d.e).

The social institution in this study is the school or more specifically the science classroom. The science classroom and the science teacher are referred to as agents of ‘symbolic control’ (Bernstein, 2000). In other words, the science classroom and the science teacher are agents characterized by certain power and control relations that are employed to achieve particular kinds of symbolic control, such as “ways of behaving, of knowing, and of thinking, ways of identifying and responding to issues, ways of

addressing problems and ways of valuing”, typical to the science classroom (Christie, 2002:162).

Power and control is the first of the four central concepts for the developmental model to be explored in this chapter. Power and control relations characteristic of the science classroom can be understood using Bernstein’s theory of classification and framing. Power and control, and classification and framing are explained further in 2.1.1.

The relationship between the science teacher and the learners is referred to as the ‘pedagogic relationship’ (Bernstein, 2000). The notion of a pedagogic relationship is a useful one because it draws attention to the following:

- (1) The authority of the teacher in initiating, facilitating and structuring the pedagogic relationship;
- (2) The learner as apprentice – it is the learner whose “consciousness is shaped” and who “acquires various ways of behaving, responding, reasoning and articulating experience of many kinds”;
- (3) The technical language of science intended to be imparted within the pedagogic relationship; and
- (4) The privileged status given to scientific discourse and the power potentially conferred upon those who are able to master it (Christie, 2002:162).

In sum, the notion of a pedagogic relationship thus views science education as enculturation.

The view of science education as a gradual apprenticeship into science in general and then into the particular scientific fields is widely held in the literature (Christie, 1997; 2001; 2002; Gee, 1996; Hodson and Hodson, 1998a; 1998b; Lemke, 1993; n.d.e; Halliday, 2004b; Martin and Rose, in press; Morais and Neves, 2001; Rose, 1997; Unsworth, 1998; Veel, 1997 and Wells, 1999).

Gee (1996) states that a way of reading a certain type of text, for example, is only acquired in a 'fluent' or 'native-like' way when an individual is embedded within a social practice wherein others read, talk about, hold certain values and attitudes, and socially interact over a text in certain ways.

However, in addition to 'teaching for acquisition', a model of apprenticeship also emphasizes 'teaching for learning'. Gee (1996:145) states that teaching that leads to learning "uses explanations and analyses that break down material into its analytic bits and juxtaposes diverse Discourses [with a capital D]¹ and their practices with each other". Such teaching, Gee states, develops a 'meta-knowledge' that can be a form of power and liberation.

Teaching for acquisition and teaching for learning are different practices; the literature advocates though that good teachers do both (Christie, 2002; Gee, 1996; Lemke, 1993; Halliday, 2004b; Martin and Rose, in press; Morais and Neves, 2001 and Wells, 1999).

The view of the teacher thus taken by the developmental model is an individual who:

- (1) Takes responsibility for the organization of the overall structure of the lesson;
- (2) Helps the learner to understand the significance of the activity as a whole and to learn the constituent actions and artifacts that mediate the performance of the activity;
- (3) Involves the learner as fully as possible; and
- (4) Provides help and guidance to the learner until the learner is able to become a fully competent and independently functioning participant (Wells, 1999:137).

¹ A discourse with a 'little "d"' is defined as "the various stretches of language that constitute much of the give and take of daily life: these are those activities of language in use which interest the applied linguist, concerned to explore the 'on site' activities and enactments of identity in which language is significantly involved." (Christie, 2002:8) In contrast 'Discourse with a big "D"' is defined as "a socially accepted association among ways of using language, other symbolic expressions, and 'artifacts', of thinking, feeling, believing, valuing, and acting that can be used to identify oneself as a member of a socially meaningful group or 'social network', or to signal (that one is playing) a socially meaningful 'role'" (Gee, 1996:131).

In addition, the view of the learner taken by the developmental model is an individual who is never simply a passive recipient of the ways of speaking that he or she encounters. Instead, it is a learner who is continuously constructing a 'personal meaning potential' and a 'related perspective on experience'; the learner thus has a unique contribution to make to the interactions in which he or she participates at every stage in his or her development and thereby an opportunity to contribute to the change of the social structure. (Wells, 1999:42).

To summarize, the pedagogic relationship is a relationship between the teacher and the learners that is at the centre of the developmental model and involves a 'moral regulation' (Christie, 2002) of the learners' behaviour in their apprenticeship into science.

Moral regulation is the second of the four central concepts for the developmental model to be explored. The moral regulation of the learners' behaviour that takes place in the pedagogic activity can be understood using Christie's (2002) adaptation of Bernstein's notion of a 'pedagogic discourse'. Moral regulation and the pedagogic discourse are explained further in 2.1.2.

Sociocultural theory also proposes that social organizations and institutions possess tools that its members use to make sense of those around them, and to those around them (Lemke, n.d.e). Learning can thus be seen as learning to use these tools to mean and to expand one's 'meaning potential' (Halliday, 1993a).

In explaining what these tools are Halliday (1993a:113) states:

The notion of learning as a semiotic process is obviously consistent with verbal learning, which includes all learning in educational contexts and much commonsense learning as well (cf. Hasan, 1992). But even nonverbal learning is learning systems of meaning, whether we envisage learning the rights and duties of kinship or learning to swim or play a musical instrument. This is characteristic of the human species: once having evolved the power of semiosis, we encode all of our experience in semiotic terms.

These tools can thus be divided into three broad categories, namely:

- (1) **Attitudes** and **values** towards the activities;
- (2) Understanding of the **practices** involved in the activities; and
- (3) Mastery of the relevant tools, such as **languages, pictorial conventions** and **specialized discourses**, for the activities (Lemke, n.d.e; and Wells, 1999).

If an ecological view of communities is taken, all the artifacts and materials an individual employs in making use of these tools also need to be included as part of the eco-social system. Collectively, these tools, i.e. the social semiotic systems and the socially meaningful ways in which they are used, are said to constitute the culture of a social organization or institution. (Lemke, n.d.e).

Thinking is thus not exclusively seen to be done in and by the brain but is seen as a kind of material action. In other words, thinking is seen to be done by:

- (1) The whole body;
- (2) Making constant use of artifacts and material tools in the surrounding environment; and
- (3) Interpreting ones own actions and their results by means of specific semiotic tools that are socially and culturally learned. (Lemke, n.d.b).

In science, where instrumentation and technologies are at the core of scientific investigation, thinking is effectively ‘distributed’ between persons and artifacts, and persons and persons. This process is mediated by artifacts, discourses, symbolic representations, and the like. (Lemke, n.d.e).

The sociocultural view of knowledge stands in contrast to the conception of knowledge held by traditional science education which Lemke (n.d.f:2) argues is a “fundamentally mentalistic” and “superficially cognitive” one. Sociocultural theory rejects the Cartesian split between body and mind. It does not view science to be a body of facts, principles,

and theories, a system of well-understood mental concepts and processes; nor does it reduce the processes of science to imaginary ‘mental’ or ‘cognitive’ processes, which occur only in an imaginary domain. Instead sociocultural theory views science as “a social subculture: a vast interlocking network of the working activities of producers and users of these products and tools” (Lemke, n.d.f:2) which can only be known by direct knowledge of its products and tools in their actual contexts of production and use; not by inference from study of them alone. (Lemke, 1993; 1995; n.d.c; n.d.d; n.d.e and n.d.f).

The semiotic tool that is foregrounded in this study is language. Halliday (1993a:113) states that language functions as the ‘signifier’ for higher level systems of meaning such as scientific theories and is the ‘prototypical resource for making meaning’. In addition, Christie (2002:10) states that in her view language is “the most fundamental resource with which participants negotiate and construct their meanings in the classroom.” The semiotic tool of the ‘languages’ (Lemke, n.d.b) of science and the values and attitudes towards the activities in the science classroom are also foregrounded in this study.

Social semiotic systems is the third of the four central concepts of the developmental model to be explored. The social semiotic system of the ‘languages’ of science can be understood using Lemke’s (1998b) theory of the ‘typological’ and the ‘topological’ and Halliday’s theory of Systemic Functional Linguistics (SFL). In addition, the social semiotic system of values and ideology can be understood using Lemke’s (1993; 1995) notion of values and ideology. Social semiotic systems, the theory of the typological and the topological, Halliday’s theory of SFL to do with the features of ‘Scientific English’ and Lemke’s notion of values and ideology are explained in 2.1.3.

Lastly, sociocultural theory proposes that human activity operates on multiple scales, i.e. from the physiological to the interactional and from the organizational to the ecological. In addition, it emphasizes that human activity operates on corresponding timescales, i.e. from the momentary to the biographical, historical and evolutionary. (Lemke, n.d.e).

Wells (1999) states that when a phylogenetic and cultural historical perspective on human intellectual development is adopted, an emphasis is placed on the role that semiotic mediation plays in enabling individuals to collaborate effectively in activities of increasing social and technical complexity. In particular, he states that the cultural means is provided for the inter-mental activity of the ‘discourse between people doing things together’ in which knowledge is developed.

The timescale in which human activity operates as a unit of work unfolds, is referred to as a ‘developmental history’ (Christie, 2002). A developmental history is the last of the four central concepts of the developmental model to be explored. The notion of a developmental history can be understood using Halliday and Matthiessen’s (1999) theory of semogenesis, in particular ‘logogenesis’. The notion of a developmental history and the theory of semogenesis are explained further in 2.1.4.

Power and control, moral regulation, social semiotic systems and a developmental history all play a role in the construction of an ‘ideal pedagogic subject position’ (Christie, 2002) for science.

A discussion of these concepts and what an ‘ideal pedagogic subject position’ is, follows in 2.1.1 – 2.1.5. In addition, as curriculum policy plays a role in shaping classroom practice, 2.1 concludes with a brief discussion on what the Revised National Curriculum Statement has to say about power and control, social semiotic systems and a developmental history.

2.1.1 POWER AND CONTROL

Power and control relations between subjects, discourses and agencies are explored in the context of the science classroom.

Power establishes legitimate relations between categories; it constructs relations **between** given forms of interaction:

Power relations, in this perspective, create boundaries, legitimize boundaries, reproduce boundaries, between different categories of groups, gender, class, race, different categories of discourse, different categories of agents. Thus, power always operates to produce dislocations, to produce punctuations in social space. (Bernstein, 2000:5)

Control establishes legitimate communications; it constructs relations **within** given forms of interaction:

Control carries the boundary relations of power and socializes individuals into these relationships...control is double faced for it carries both the power of reproduction and the potential for its change. (Bernstein, 2000:5)

Classification is used in this study for the translation of power, and framing for the translation of control in the interpretation and analysis of the data. (Bernstein, 2000; and Morais and Neves, 2001).

Classification is “a defining attribute not of a category but of the relations *between* categories” (Bernstein, 2000:6). Bernstein (2000) provides the following example: He states the discourses of a secondary curriculum, which he calls A, B, C and D, must have a space in which to develop their unique identity, i.e. an identity with its own internal rules and special voice, if they are to be differentially specialized. In addition, he states that these discourses may be considered a social division of labour of discourse.

The crucial space that creates the specialization of a category is therefore considered to be between that discourse and another, not internal to that discourse. In other words, the principle of the relations between categories is a function of the degree of insulation between categories. The degree of insulation between categories (categories of discourse, gender etc.) is what distinguishes strong classification from weak classification. In addition, what preserves this insulation is power. (Bernstein, 2000).

In this study, the concept of classification has been used in the analysis and interpretation of the data to examine the degree of boundary maintenance between ‘contents’ in terms of:

- (1) Content that is specific and not specific to ‘the lesson’;
- (2) Scientific and non-scientific discourse;
- (3) Commonsense and uncommonsense knowledge; and
- (4) Scientific and non-scientific texts.

The third element that can characterize a pedagogic social context, namely, commonsense knowledge, is defined as knowledge that is familiar and readily available; uncommonsense knowledge, in contrast, is defined as knowledge that is unfamiliar and involves the use of specialist or technical language (Christie, 2002).

A classroom in which a strongly classified curriculum applies makes a distinction between ‘commonsense’ and ‘uncommonsense’ knowledge; the learners are apprenticed into uncommonsense knowledge.

Christie (2002) states that the development of control over uncommonsense knowledge requires investment of effort over time, i.e. a curriculum practice which is marked by a ‘developmental history’ as the learners appropriate the language of science and the reasoning encoded in it. In 2.1.4, the concept of a ‘developmental history’ (Christie, 2002) is explained. In addition, Christie states, to develop uncommonsense knowledge requires the guidance and intervention of a mentor.

Martin (1992) differentiates between commonsense and uncommonsense knowledge by using the following system network:

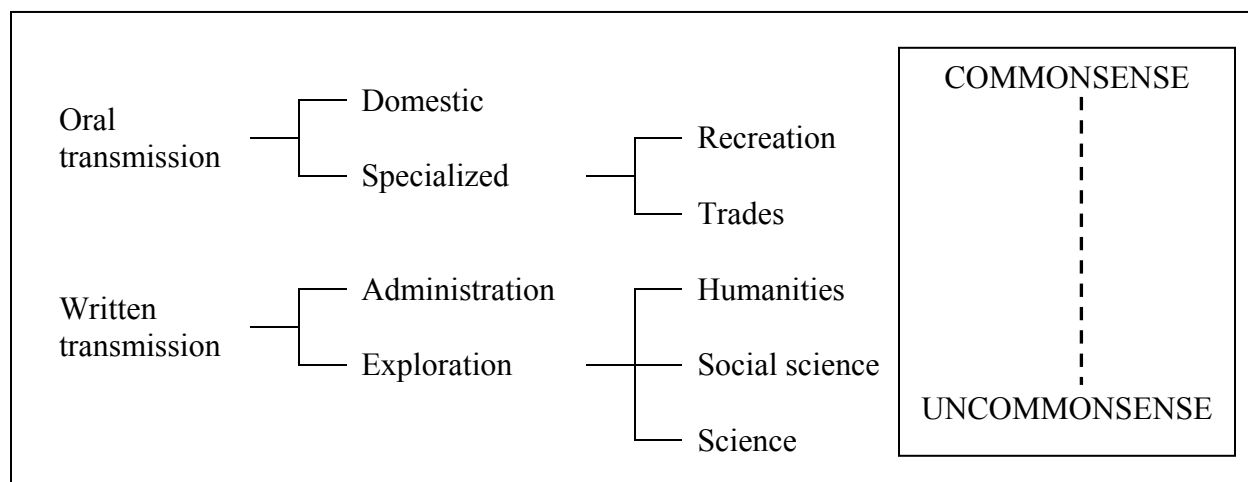


Figure 2.1.1 Martin's (1992) provisional classification of fields (Painter, 1996:53)

In brief, the system network provided by Martin (1992) proposes that the 'domestic' field, mediated by spoken language, is learned by doing. In contrast, the 'exploration' fields of institutionalized knowledge, mediated largely by written language, are learned through instruction. (Painter, 1996).

Halliday (2004e:48) states that "the discourses of science gain their theoretical power precisely because they are not translatable into commonsense terms." This statement is explained further in 2.1.3 when grammatical metaphor, a feature of 'Scientific English', is explained to increase the power that a language has for theorizing. However, Halliday (2004e:47-48) states further that there is a paradox: in grammatical metaphor² everything shifts in the direction of the concrete, i.e. in order to stabilize the text "a semiotic universe made of things" is created by the grammar. The most abstract theorizing, therefore, is achieved by modelling everything on the concrete.

Lastly, Lemke (n.d.d) proposes that a learner's alternative conceptions and scientific knowledge belong to alternative frameworks: Whereas scientific explanations belong to the culture of science, a culture that seeks particular kinds of knowledge for particular

² Grammatical metaphor involves transference from a 'congruent' form of expression, e.g. move, to a 'non-congruent' or 'metaphorical' one, e.g. motion (Christie, 2002 and Veel, 1997).

purposes and has agreed upon rules of evidence and argumentation, everyday knowledge belongs to the cultures of everyday life, a culture that also seeks knowledge but for different purposes where the criteria of validity are correspondingly different - a choice between two scientific explanations can therefore be made, a choice between a scientific explanation and an everyday explanation cannot. Science, Lemke (n.d.d) states, is therefore a particular subculture with a system of beliefs and values that teachers need to be aware they are inviting learners to join.

The fourth element that can characterize a pedagogic social context, namely scientific texts are texts such as descriptive reports, taxonomic reports, procedural recounts, causal explanations, etc. (Veel, 1997); in contrast, non-scientific texts are texts such as narratives, dialogues, poems, comic strips, etc.

A classroom in which a strongly classified curriculum applies makes a distinction between scientific and non-scientific texts; the learners are apprenticed into comprehending and producing scientific texts.

In the context of the science classroom it is argued that scientific texts are more valued by the teacher, school and society than non-scientific texts irrespective of the model of pedagogy adopted (Bernstein, 2000; Cazden, 1988; Christie, 2002; Gee, 1996; Lemke, 1993; Martin, 1993; Morais and Neves, 2001; Muller, 2000; Schleppegrell, 2001; Unsworth, 1998 and Veel. 1997); Christie (2002:32) states:

...regardless of what 'content' is to be dealt with, and what claims on learning and thinking such 'content' might be held to have [i.e. regardless of the model of pedagogy adopted], development of language competence will be held to be both a desirable and an achievable goal.

A classroom in which a weakly classified curriculum applies in which the teaching of scientific texts are not given priority is said to place learners at a disadvantage, in particular learners from low socio-economic backgrounds; Morais and Neves (2001:216) state:

Such practices leave the text legitimized by school and society invisible, increasing the differences marking children of distinct social and cultural backgrounds on entering school.

To be able to produce a text in a given context, such as the science classroom, the learners are said to need to possess the specific coding orientation to that context (Bernstein, 2000). In other words, the learners need to possess ‘recognition rules’, i.e. “be able to recognize the context”, and ‘realization rules’, i.e. “be able to produce a text adequate to that context” (Morais and Neves, 2001:195); Bernstein (2000:17) states:

Many children of the marginal classes may indeed have a recognition rule, that is, they can recognize the power relations in which they are involved, and their position in them, but they may not possess the realization rule. If they do not possess the *realization rule*, they cannot speak the legitimate text. These children in school, then, will not have acquired the legitimate pedagogic code, but they will have acquired their place in the classificatory system.

To summarize, it is recognized that for the learners to acquire the recognition and realization rules needed for text production, evaluation criteria need to be explicated and the teacher is to have control, at least at the macro level, over selection of the content (Morais and Neves, 2001).

The second element that can characterize a pedagogic social context, namely scientific and non-scientific discourse, is explained in 2.1.3.1.

Framing is about “*who* controls *what*”; it is to do with the “internal logic of the pedagogic practice” (Bernstein, 2000:12)

Bernstein (2000:12-13) states that framing for the pedagogic social context is to do with the nature of the control over:

- (1) The selection of the communication;
- (2) Its sequencing;

- (3) Its pacing;
- (4) The criteria; and
- (5) The control over the social base which makes this transmission possible.

The concept of framing has been used in the analysis and interpretation of the data to examine the abovementioned elements that can define the pedagogic social context. Bernstein (2000) states that more control over the elements is ascribed to the transmitter when the framing is strong and more control, but only apparent control, is ascribed to the acquirer when the framing is weak. In addition, Bernstein states that it is possible for framing values to vary with respect to the elements of the pedagogic social context. In other words, framing over pacing can be weak whilst framing over other aspects of the discourse is strong.

Lastly, Bernstein (2000:13) distinguishes between two systems of rules, namely ‘rules of social order’ and ‘rules of discursive order’, regulated by framing. The ‘rules of social order’ are said to refer to “forms that hierarchical relations take in the pedagogic relation” and to “expectations about conduct, character and manner”. In contrast, the ‘rules of discursive order’ are said to refer to the “selection, sequence, pacing and criteria of the knowledge”. The former system is also referred to as the ‘regulative discourse’ and the latter the ‘instructional discourse’. The regulative and instructional discourse are explained further in 2.1.2.

2.1.2 MORAL REGULATION

Moral regulation in terms of the science classroom has at least two dimensions, namely: (1) A moral regulation to do with establishing what constitutes acceptably ‘good’ behaviour; and (2) A moral regulation to do with establishing behaviour to do with “patterns and methods of handling information, reasoning, thinking, arguing, describing and explaining particular to the instructional field” that is said to be ‘delocated’ from elsewhere, ‘relocated’ to the classroom and ‘transmitted’ in the pedagogic activity (Christie, 2002:163).

The former dimension, namely moral regulation to do with what constitutes acceptably 'good' behaviour, operates more 'audibly and consistently' in the earlier years of schooling. As the learners become more familiar with the behavioural routines of the science classroom, however, it becomes less noticeable over time and eventually finds implicit expression only; a measure of its importance in the totality of what constitutes acceptable pedagogic behaviour. Although these two dimensions are in one way of a different order, they are in another way "merely manifestations of the same process at work", that of "shaping pedagogic subjects as they learn methods and manners of functioning in the classroom, where these are valued for their relevance for participation in the wider world beyond school". (Christie, 2002:167).

The former dimension is used in this study to examine the transmission of values in the pedagogic activity; it is foregrounded in 4.2. The latter dimension is used in particular to examine the verbal, mathematical and visual 'languages' (Lemke, n.d.b) that the learners are inducted into in the pedagogic activity; it is foregrounded in 4.2 and 4.3.

To understand the moral regulation of the learners' behaviour I have used Christie's (2002) adaptation of Bernstein's notion of a 'pedagogic discourse' as a tool of analysis in the interpretation and analysis of the data.

The pedagogic discourse is defined as a rule which embeds two discourses; a regulative and an instructional discourse (Bernstein, 2000).

Bernstein represents this relation as follows:

INSTRUCTIONAL DISCOURSE	ID
REGULATIVE DISCOURSE	RD

Figure 2.1.2-I The relation between the instructional and the regulative discourse (Bernstein, 2000:32)

Figure 2.1.2-I suggests that the instructional discourse is embedded in the regulative discourse; and that the regulative discourse is the dominant discourse (Bernstein, 2000). Christie (2002) adopts the term ‘register’ in the place of ‘discourse’ and Christie (2002) and Martin and Rose (in press) adopt the term ‘project’ in the place of ‘embed’ as these terms fit more easily in line with the linguistic theory that informs their research. As their work (and the research done by other linguists) has been drawn upon extensively in this study I have chosen to adopt these terms in the interpretation and analysis of the data as well.

Martin and Rose (in press) represent the relation between the instructional discourse (ID) and the regulative discourse (RD) as follows:

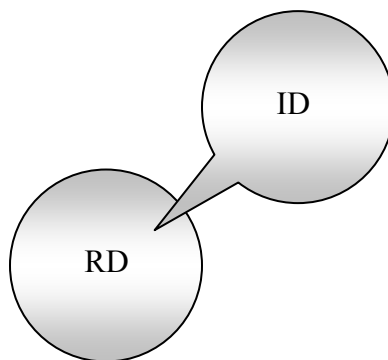


Figure 2.1.2-II The instructional discourse projected by the regulative discourse (Martin and Rose, in press:18)

Figure 2.1.2-II suggests that the regulative discourse and the instructional discourse are inseparable (Bernstein, 2000); Martin and Rose (in press), in stating how the one discourse cannot exist without the other, liken the instructional discourse to a locution and the regulative discourse to the speaker's voice from which the locution comes.

The regulative discourse brings the classroom text into being, and determines the sequencing, pacing, directions, and evaluation criteria for an activity (Christie, 2002:162); it is said to involve choices to do with language that regulate, direct and maintain the pedagogic activity (Christie, 1997:157-158).

In contrast, the instructional discourse realizes the 'content' or 'specialist experiential information' that constitutes a lesson (Christie, 2002:162); it is said to involve choices to do with language that realize the instructional field selected from elsewhere for the purposes of the lesson (Christie, 1997:158).

In the opening stages of a 'macrogenre', such as a unit of work, or a 'curriculum genre', such as a classroom discussion, the regulative discourse³ is typically foregrounded (Christie, 2002):

Now, remember, you are doing your own notes for your own sakes...Remember, some of you put your notes into rough, and then put them into neat. Others of you go straight into neat. It's up to you.

In a subsequent element or elements the two discourses may converge as the task is specified (Christie, 1997):

Right the two we are going to talk about is, 'cause this is a mechanics section, the two we are going to talk about is potential energy and kinetic energy. Right, now, let's be more specific we are going to talk about gravitational potential energy.

³ In this study a similar method is adopted to that employed by Christie (2002) to suggest the operation of the regulative and the instructional register; in Chapter 4, **bold text** is used to suggest the operation of the regulative register and plain text to suggest the operation of the instructional register.

Then as the learners research and explore the instructional field, the instructional discourse may be foregrounded (Christie, 1997):

So, for the water for the waterfall or her eraser, it started with potential energy, what in the end changed into? Kinetic energy. Kinetic energy. It got faster and faster as it went down⁴.

Lastly, in the final element as the learner becomes “a fully competent and independently functioning participant” (Wells, 1999:137) the regulative discourse will disappear; however, the regulative discourse does continue to operate tacitly and this is an important measure of its success (Christie, 1997).

In sharpening the concept of the pedagogic discourse, Bernstein (2000:32) states that the pedagogic discourse is a recontextualizing principle. In other words, Bernstein explains that the pedagogic discourse is a principle for ‘delocating’ a discourse from its original site of effectiveness, such as the university, and for ‘relocating’ it to a pedagogic site, such as the classroom.

Christie (1997:157) explains the recontextualizing principle as a principle that is involved in the operation of the pedagogic discourse. The regulative discourse, i.e. the discourse to do with the directions, sequencing, pacing and evaluation of an activity, is said to take or ‘delocate’ the instructional discourse, i.e. the discourse to do with ‘content’ that constitutes the substance of a lesson, from elsewhere and relocate it for the purposes of its selective transmission.

In the process of delocating a discourse, i.e. in taking the discourse from its original site of effectiveness and moving it to a pedagogic site, a space is created in which ideology can play (Bernstein, 2000). In other words, the discourse is ideologically transformed; it

⁴ Unless otherwise stated the illustrative examples used in the Literature Review are from the data generated in this study.

is not the same discourse any longer. Bernstein (2000) claims that no discourse ever moves without ideology at play. The concept of ideology is explained further in 2.1.3.2.

2.1.3 SOCIAL SEMIOTIC SYSTEMS

2.1.3.1 THE 'LANGUAGES' OF SCIENCE

Communication in the science classroom is said to take place through 'multiple literacies' (Lemke, 2000). These literacies include verbal (or written); mathematical and visual literacies. Verbal language is used to describe 'categorical difference and co-distribution'. Lemke (1998b) refers to this type of meaning as 'typological'. In other words, verbal language is used as a tool for "the formulation of difference and relationship [and] for the making of categorical distinctions" in the science classroom (Lemke, 1998b:3). This can be illustrated, as shown in *Figure 2.1.3.1-I* below, where 'heat', 'sound', 'light', 'electrical', 'chemical', 'potential', and 'kinetic', are different forms, but related to the central concept of 'energy'.

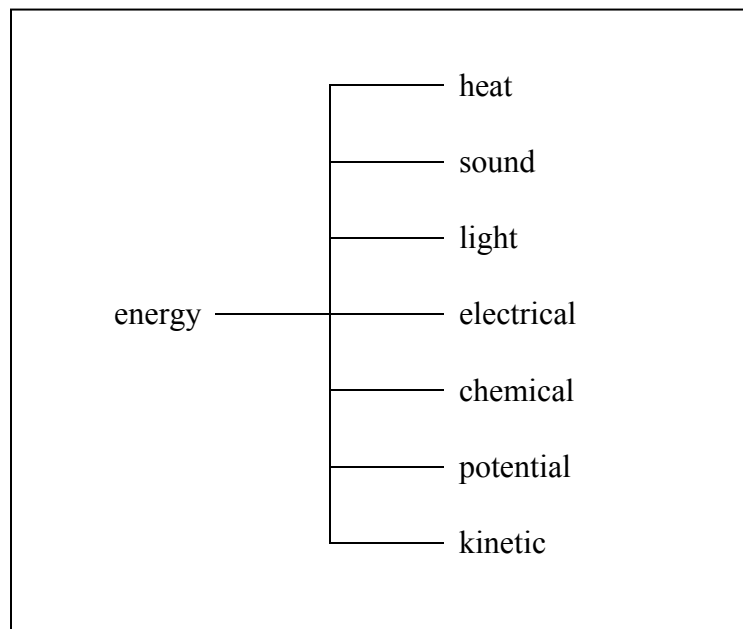


Figure 2.1.3.1-I A system network for energy

In contrast, visual and mathematical ‘language’ (Lemke, n.d.b) is used to describe ‘continuous change and co-variation’. Lemke (1998b) refers to this type of meaning as ‘topological’. In other words, visual and mathematical language is an important resource in the science classroom for:

...formulating degree, quantity, gradation, continuous change, continuous co-variation, non-integer ratio, varying proportionality, complex topological relations of relative nearness or connectedness, the interpenetration of different dimensionalities, or nonlinear relationships and dynamical emergence. (Lemke, 1998b:3)

This can be illustrated, as shown in *Figure 2.1.3.1-II* on pp.32, where the line drawn to depict the coastline of South Africa is a line that shows the ‘continuous change and co-variation’ of the land where it meets the water.

Visual and mathematical literacies evolved to form “a bridge between the linguistic and the visual-gestural” (Lemke, n.d.b:13). In the science classroom this is important because the phenomena of scientific investigation possess critical features of both the typological and the topological, i.e. categorical descriptions and quantitative reasoning is needed to characterize the material processes and their relationships in the science classroom (Lemke, n.d.b). Lemke (n.d.b) states that the following two points to do with the evolution of visual and mathematical literacies in the science classroom are relevant:

- (1) Measurements play an important role: When scientists make measurements quantitative representations are used. These are then linked to the qualitative observations made at the same time to describe the phenomena. Quantitative representations are needed because material processes and their dynamics are ‘matters of covariation among continuous variables’.
- (2) And the actions of the teacher or science learner play an important role: When scientists move their actions are not only material processes, ‘matter in motion’, but also have ‘meaning beyond their physical causality’. The actions of the

scientist thus form one more semiotic system that allows the scientist to coordinate his/ her ‘doings’ with other verbal, visual and mathematical meanings.

To understand the ‘languages’ of science Lemke’s (1998b) theory of the typological and the topological is used in the interpretation and analysis of the data in this study; in addition, to understand the typological, Halliday’s theory of Systemic Functional Linguistics (SFL) is used.

The typological, i.e. verbal (or written) language, is recognized as ‘Scientific English’ by the combined effect, rather than the obligatory presence of any particular one, of the following features, namely: (1) grammatical metaphor; (2) abstraction; (3) lexical density; and (4) consequential conjunctions (Halliday, 1993b). Although there are other features of ‘Scientific English’, I have chosen to discuss these four features in 2.1.3.1 because they receive the greatest prominence in the literature (Bloor and Bloor, 2004; Christie, 2002; Eggins, 1994; Halliday, 1993a-b; 1994; 2004a-h; Lemke, 1995; Martin, 1997; Martin and Rose, 2003; Painter, 1996; Rose, 1997; Schleppegrell, 2001; Unsworth, 1998; and Veel, 1997).

(1) Grammatical metaphor involves transference from a ‘congruent’ form of expression, such as the verb ‘compress’, to a ‘non-congruent’ or ‘metaphorical’ one, such as the noun ‘compression’ (Christie, 2002 and Veel, 1997). Halliday (2004h:xvii) states:

Grammatical metaphor creates virtual phenomena – virtual entities, virtual processes – which exist solely on the semiotic plane; this makes them extremely powerful abstract tools for thinking with. Thus what grammatical metaphor does is to increase the power that a language has for **theorizing**.

One of the most widespread manifestations of grammatical metaphor involves nominalization (Bloor and Bloor, 2004). Lemke (1995:60) states that “In brief, nominalization allows an entire activity, a Process complete with its typical Participants and Circumstances, to be understood merely by naming it with the process noun.” An example of nominalization is when the more congruent form ‘The object [Participant]

moves [Process] from one place to another place [Circumstances]' is given the more metaphorical form of expression '*motion*'.

(2) Abstractions, like nominalizations, also construe 'virtual entities'. However, unlike nominalizations, abstractions do not involve a process of transference. In other words, whereas a nominalization can be 'unpacked' into a more 'congruent' form, this is not as easily done with abstractions. The reason for this is that abstractions do not have a semiotic 'history' in the way that grammatical metaphors do. (Martin, 1997 and Veel, 1997).

Abstract technical terms, when they are taught for the first time in primary school, mark the move into, or in the direction of, grammatical metaphor as they too are 'virtual entities'. However, it is only in high school, with its discipline-based and 'theoretical' forms of knowledge that an individual begins to learn through a language in which the metaphorical mode of expression predominates. Examples of abstractions are 'force' and 'energy'. (Halliday, 2004h).

(3) An increase in the lexical density for a text indicates a movement from 'commonsense' to 'uncommonsense' knowledge (Veel, 1997). Veel (1997:183) states:

Non-specialist spoken language typically has a lexical density of about two items per clause. The more abstract a text is, the more removed from the here-and-now, the greater the lexical density.

For example, the following definition for 'displacement', namely 'Displacement is a change in position in a given direction.' has a lexical density of five, i.e. five lexical words per clause. (Halliday, 2004a and Veel, 1997).

(4) Finally, Martin and Rose (2003) identify four general kinds of logical relations that conjunctions realize in English discourse, namely: (1) adding figures together ('addition'); (2) comparing them ('comparison'); (3) sequencing them in time ('time'); and (4) explaining their causes, purposes or conditions ('consequence'). Veel (1997)

states that an increase in consequential conjunctions for a text, like an increase in nominalization and lexical density, indicates a movement away from the ‘here-and-now of everyday life’ towards more abstract discourse. In the following example, ‘If speed is zero, so we say, the force here equals zero because no speed’, consequential conjunctions of condition, purpose and cause are realized in the utterance.

The topological, i.e. mathematical and visual ‘language’, is best understood in terms of its relation to a ‘scientific concept’. Lemke (1993; 1998b; 2000; n.d.a and n.d.b) states that a scientific concept is a ‘semiotic hybrid’, i.e. a scientific concept is simultaneously and essentially ‘verbal-typological’ and ‘mathematical-graphical-operational-topological’. In other words, the meaning of a ‘scientific concept’ does not arise from the addition of semiotic systems or by these systems acting in parallel to each other, as illustrated in *Figure 2.1.3.1-II* below. Instead, it arises from the integration of semiotic systems and by the meaning of these systems being multiplied by each other. Lemke (n.d.b:7) states:

From this multiplication of meaning comes the great power of scientific concepts and of scientific reasoning: in scientific reasoning we can freely and self-consistently move back and forth between verbal reasoning, visual reasoning, quantitative reasoning, mathematical symbolic logic, and operational situated sense-making.

For example, the concept of ‘direction’ is expressed **verbally**, i.e. ‘lies at a bearing of’; **mathematically**, i.e. $45^\circ + 45^\circ = 90^\circ$, and **visually**, i.e. \longrightarrow , as shown in *Figure 2.1.3.1-II* below⁵.

⁵ Unless otherwise stated the illustrative examples used in the Literature Review are from the data generated in this study.

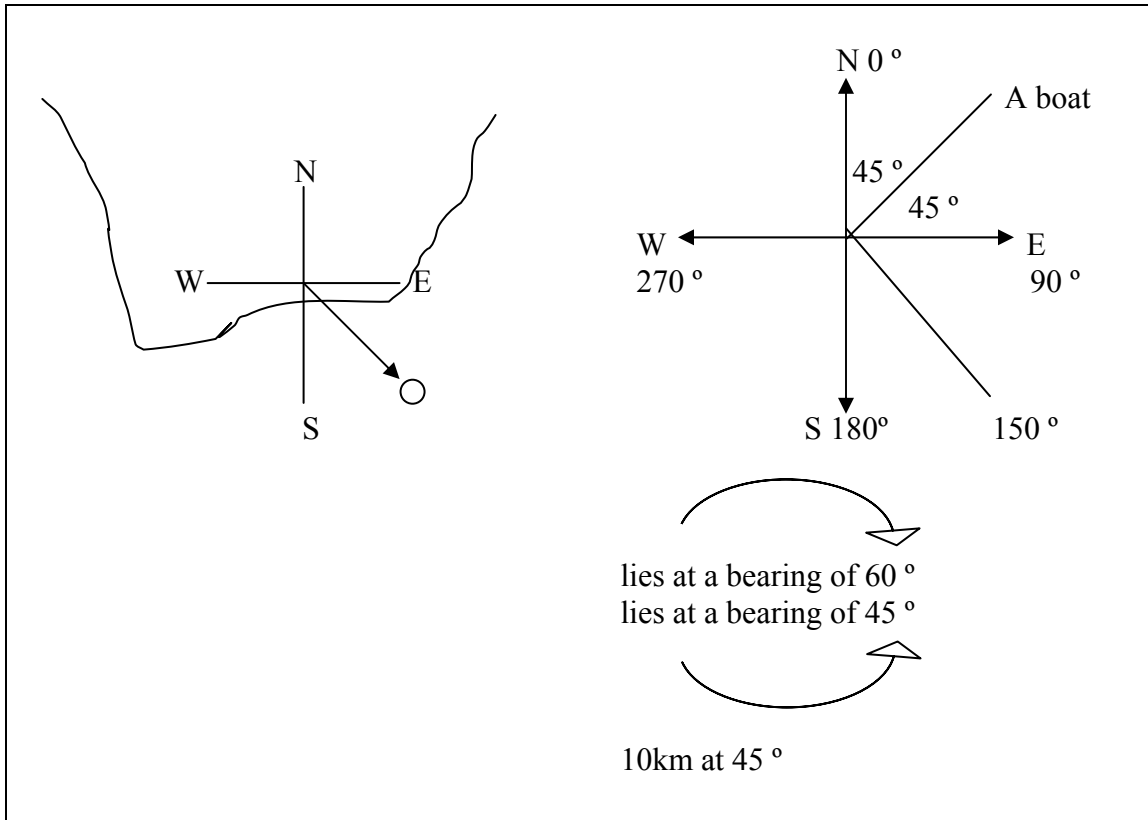


Figure 2.1.3.1-II The multiple semiotic representations for the concept of direction

It is thus evident that, as Unsworth (1998:200) states, “developing a student’s knowledge and understanding in science, and developing their knowledge of the language that constructs and communicates that understanding, is one and the same thing”.

2.1.3.2 VALUES AND IDEOLOGY

The terms ‘values’ and ‘ideology’ are used variously in the literature: In ‘Talking Science: Language, Learning and Values’ Lemke (1993) foregrounds the term values and in ‘Textual Politics: Discourse and Social Dynamics’ (1995) he foregrounds the term ideology; in both texts, however, the concept of values (or ideology) as it is used by Lemke tries to sum up the following central insight, namely:

...there are some very common meanings we have learned to make, and take for granted as common sense, but which support the power of one social group to dominate another. (Lemke, 1995:2)

In this study, the central insight the concept of values (or ideology) tries to sum up is acknowledged. In addition, the term 'values' tends to be reserved for 'the standards of behaviour' and the term 'ideology' tends to be reserved for 'the set of beliefs held by a particular group' (Oxford English Dictionary).

Values and ideology are recognized to be inseparable from what takes place in the science classroom: what topics are chosen, what is emphasized, how the relationship between commonsense and uncommonsense knowledge is posed, how science is spoken about in relation to other subjects. All of these, Lemke (1993:46) states, embody certain values and prejudices.

Bernstein (2000:32) states that the view of most researchers is that education is about values (or ideology) on the one hand and about 'competence' on the other; however, in his view, the two are inseparable – there is only one discourse, he states, not two. In this study, as discussed in 2.1.2, the pedagogic discourse is treated as one discourse, i.e. a principle which embeds two discourses, namely a regulative and an instructional discourse.

Lastly, Lemke (1995) states that the features of scientific discourse, some of which were discussed in 2.1.3.1, play a role in the ideology that underpins scientific discourse. In particular, the following two features are important, namely:

- (1) Thematic condensation; and
- (2) Monologic orientation (Lemke, 1995).

Firstly, thematic condensation occurs through nominalization. Lemke (1995) states that the complete meanings of a text that relies on this strategy are only recoverable by individuals already familiar with the 'thematic formations' of relevant intertexts in which

the meanings are explicitly presented. As a result, Lemke (1995:60) states, thematic condensation “divide[s] the world of potential readers into initiates and the uninitiated”.

Secondly, the monologic orientation of scientific discourse occurs through the use of the third person and passive voice. Lemke (1995:60) states that a text that relies on these strategies presents the world of scientific discourse as “a closed world which admits no criteria of validity outside its own”. In addition, he (1995:61) states it presents scientific discourse as “true for all time”, “outside human dialogue or opinion” and “independent of the particular human agent who has happened upon ‘the facts’ ”.

These features, Lemke (1995) argues, are shaped historically by a cultural ideology that preserves the role and image of science in society; thematic condensation and monologic orientation, he (1995:61) states, “serve to establish and maintain a social elite, its claims of privilege and its access to power”.

Lemke’s (1993; 1995) notion of values and ideology is used in the interpretation and analysis of the data to understand the values and ideology that underpin the language in the science classroom that I investigated.

2.1.4 A DEVELOPMENTAL HISTORY

Lastly, the notion of a ‘developmental history’ (Christie, 2002) is explored in the context of the science classroom. Christie (2002:177) uses the term ‘developmental history’ to define the learning that takes place in a ‘successfully’ taught unit of work; learning that is “sustained”, “engages seriously with ‘uncommonsense knowledge’”, and “requires the investment of effort over time”.

To understand the developmental history of a unit of work I have used Halliday and Matthiessen’s (1999) theory of semogenesis, in particular logogenesis, in the interpretation and analysis of the data in this study.

Logogenesis is to do with “the unfolding of the text itself, moving from its beginning to its middle to its end” (Christie, 2002:97; Martin and Rose, 2003); Christie (1997:148) states:

As the macrogenre [for example, the unit of work] unfolds, there will be some growth in the *logos* – some changes logogenetically (Halliday in Halliday and Martin, 1993:18) – as the classroom text gains momentum, moving forward across its ‘beginning, middle, end’ progression, opening up possibilities in using language, closing others, and hence building forms of consciousness.

The notion of ‘logogenesis’ is useful because it allows changes in the language used to be traced across a sequence of ‘curriculum genres’, such as a classroom discussion, a brainstorming session, etc., to provide evidence of ‘educational development’ (Christie, 2002:97).

Christie (1997:148) states that a less successfully taught unit of work will at best have a sequence of lessons that are ‘loosely thematically linked’, not ‘a relationship of real interdependency’; in other words the sequence of lessons will lack logogenesis. In contrast, Christie (2002) explains that, a successfully taught unit of work will reveal shifts and some kind of developmental progress in the language use as the technical language and the reasoning encoded in it is appropriated by the learners; in other words the unit of work will be marked in the classroom discourse by any number of possible forms of logogenesis.

The term logogenesis is best understood if it is contrasted with other kinds of genesis, such as ‘ontogenesis’ and ‘phylogenesis’ (Halliday and Matthiessen, 1999). Ontogenesis is to do with “the growth, maturity and eventual death of language in the individual” (Christie, 2002:97; Martin and Rose, 2003). Halliday (2004e) states that as an individual learns new ways of meaning he/ she passes through three stages, or ‘critical moments’. The critical moments can be characterized by the changes brought about in terms of grammar or knowledge.

Firstly, the critical moments to do with grammar are:

- (1) The move from protolanguage⁶ to language;
- (2) The move from the grammar of everyday spoken language to that of written language; and
- (3) The move from the grammar of written language to the language of the subject disciplines.

Secondly, the critical moments to do with knowledge are:

- (1) The move into commonsense knowledge (age 1-2);
- (2) The move into educational knowledge (age 4-6); and
- (3) The move into technical knowledge (age 9-13).

As alluded to in 2.1.3.1 the three critical moments are also enacted through a ‘critical progression’, namely from ‘generalization’ to ‘abstractness’ and finally to ‘metaphor’. The first move is thus said to enable an individual to “construe experience” whilst the second and third move are said to enable the individual to “reconstrue experience in an increasingly theoretical mode” (Halliday, 2004e:27).

Phylogenesis is to do with “the language system and its evolution over time” (Christie, 2002:97; Martin and Rose, 2003). The relationship between phylogenesis, ontogenesis and logogenesis can be represented as shown in *Figure 2.1.4* below.

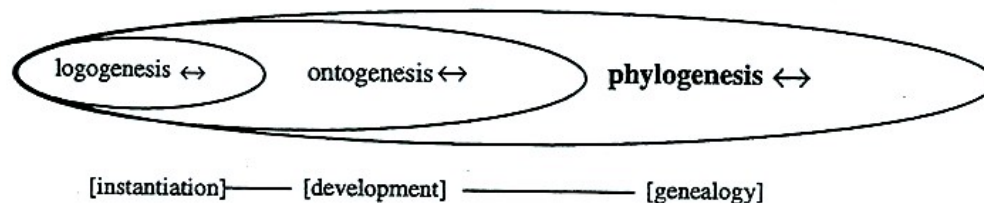


Figure 2.1.4 Time frames and semogenesis (Martin, 1997:9)

⁶ Protolanguage is defined as the inventory of differentiated signs that babies use to explore and control their world as they gain primary consciousness through the separation of ‘self’ from the surrounding environment (Halliday, 2004e).

Figure 2.1.4 suggests that phylogenesis provides the environment for ontogenesis, and ontogenesis the environment for logogenesis. In other words, Martin (1997) states the stage a language has reached in its evolution over time provides the resources for the development of language in the individual, and this in turn provides the resources for the instantiation of the unfolding of a text. Conversely, *Figure 2.1.4* suggests that logogenesis provides the material for ontogenesis, and ontogenesis the material for phylogenesis. In other words Martin (1997:9) states it is through the instantiation of the unfolding of a text that individuals interact, and it is through the ‘heteroglossic aggregation of individual systems’ that the meaning-making path for a culture evolves.

Language change can thus be understood as an expanding ‘meaning potential’. This is recognized to be a key feature of semiotic systems as they adapt to new discursive and non-discursive environments. (Martin, 1997; Martin and Rose, 2003).

2.1.5 AN IDEAL PEDAGOGIC SUBJECT POSITION

The pedagogic discourse constructs an ‘ideal pedagogic subject position’ (Christie, 2002). Bernstein (2000:31) states:

Pedagogic discourse itself rests on the rules which create specialized communications through which pedagogic subjects are selected and created. In other words, pedagogic discourse selects and creates specialized pedagogic subjects through its contexts and contents.

In this study, the ‘context’ is the science classroom and the ‘contents’ explored are the social semiotic systems of ‘languages’ and ‘values and ideology’ particular to the science classroom.

Christie (1997:157) states that ‘forms of consciousness’ are adopted as a particular pedagogic subject position is constructed in the pedagogic discourse helped by the manner in which the pedagogic discourse is transmitted, its pacing and its sequencing.

As we have seen in this section, classification (used for the translation of power) is used as a tool of analysis to understand ‘the manner in which the pedagogic discourse is transmitted’ and framing (used for the translation of control) is used as a tool of analysis to understand the ‘pacing’ and the ‘sequencing’ of the pedagogic discourse.

Finally, the ‘manner in which the pedagogic discourse is transmitted’, its ‘pacing’ and its ‘sequencing’ play a role in determining the presence or absence of a developmental history (Christie, 2002).

It can thus be concluded that power and control, moral regulation, social semiotic systems and a developmental history all play a role in the construction of an ideal pedagogic subject position for science.

However, Christie (1997) notes that as learners perform variously at school and as they bring different ‘meaning orientations’ to the school, shaped by their personal experiences, learners do not adopt the same pedagogic subject position, nor do they adopt it in the same way.

2.1.6 THE REVISED NATIONAL CURRICULUM STATEMENT

The following central concepts of the developmental model, namely power and control, social semiotic systems and a developmental history, are addressed variously in the Revised National Curriculum Statement (RNCS). The manner in which the concepts are addressed has been influenced by:

- (1) The impact of the ‘competence’ (Bernstein, 2000) model of education;
- (2) The attention the concept of values has received; and
- (3) The recognition that has been given to the importance of progression across the grades during this time of curriculum reform.

A ‘competence’ (Bernstein, 2000) model of education is associated with an ‘invisible pedagogy’ characterized by: (1) an implicit hierarchy in terms of the pedagogic relationship; (2) implicit sequencing rules in terms of the lesson; and (3) implicit criteria of evaluation. It stands in contrast to a ‘performance’ (Bernstein, 2000) model of education, associated with a ‘visible pedagogy’ characterized by: (1) an explicit hierarchy in terms of the pedagogic relationship; (2) explicit sequencing rules in terms of the lesson; and (3) explicit and specific criteria of evaluation. (Martin and Rose, in press:2).

The impact of a competence model of education is evident from the three distinctive sources, identified in the ‘Report of the review committee on Curriculum 2005’, said to have played a role in the conceptualization and design of Curriculum 2005, namely:

- (1) A learner-centered philosophy of education;
- (2) Outcomes-based education; and
- (3) An integrated and non-disciplinary division of knowledge (South Africa, 2000c:28).

The impact of the competence model is also evident upon examination of the RNCS in light of the characteristics provided by Bernstein (2000) for a competence model of education:

CHARACTERISTICS OF A COMPETENCE MODEL	RNCS
“an announcement of a universal democracy of acquisition” (Bernstein, 2000:43)	“It acknowledges that all learners should be able to develop to their full potential provided they receive the necessary support” (South Africa, 2003a:4)
“the subject is active and creative in the construction of a valid world of meanings and practice” (Bernstein, 2000:43)	“Most learners within South African classrooms think in terms of more than one world-view.” (South Africa, 2003b:31)
“an emphasis on the subject as self-regulating, a benign development” (Bernstein, 2000:43);	
“formal instruction is given a reduced significance” (Christie, 2002:174)	“The subject Physical Sciences focuses on investigating physical and chemical phenomena through scientific inquiry” (South Africa, 2003a:9)

“a critical, skeptical view of hierarchical relations” (Bernstein, 2000:43)	“The kind of teacher that is envisaged...mediators of learning” (South Africa, 2003a:5)
“a shift in temporal perspective to the present tense” (Bernstein, 2000:43)	“Attainment is evident when the learner, for example” (South Africa, 2003a:17)

Figure 2.1.6-I The characteristics of a competence model and the RNCS

Lastly, the impact of the competence model is evident from the manner in which the following issues are addressed, namely (1) integration to do with ‘content’; (2) commonsense and uncommonsense knowledge; (3) scientific and non-scientific discourse; (4) scientific and non-scientific texts; and (5) the role of the teacher relevant to the notion of power and control and semiotic systems as discussed in 2.1.1 – 2.1.4.

A discussion of the abovementioned issues follows:

(1) The RNCS promotes integration across subjects; the RNCS (South Africa, 2003c:3) for grades 10 – 12 states:

Integration is achieved within and across subjects and fields of learning. The integration of knowledge and skills across subjects and terrains of practice is crucial for achieving applied competence as defined in the National Qualifications Framework.

(2) The RNCS emphasizes the ‘experiences’ of the learners; the RNCS (South Africa, 2003c:34) for grades 10 – 12 states:

The contexts suggested will enable the content to be embedded in situations which are meaningful to the learner and so assist learning and teaching. The teacher should be aware of and use local contexts, not necessarily indicated here, which could be more suited to the experiences of the learners [emphasis mine].

The RNCS also emphasizes the different ‘world views’ the learners bring to the class and promotes the teaching of indigenous knowledge; the RNCS for grades 10 – 12 (South Africa, 2003c:4) states:

The National Curriculum Statement Grades 11 – 12 (General) has infused indigenous knowledge systems into the Subject Statements. It acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution. As many different perspectives have been included to assist problem solving in all fields.

(3) The RNCS does not recognize the role of language in the construction of reality; the RNCS for grades R – 9 (South Africa, 2002:45) states the following for the grade 7 – 9 learner in the ‘Senior Phase’:

The learner can now use language to make finer distinctions, which demonstrates a better grasp of reality [emphasis mine]. For example, the learner can distinguish ‘air’ from ‘steam’, and ‘steam’ from ‘smoke’, and ‘water vapour’ from ‘air’ and the learner can also explain how the concepts ‘air’ and ‘atmosphere’ relate to each other.

The RNCS also does not emphasize the importance of language in the construction of reality as the scientist sees it, the RNCS (South Africa, 2003b:30) for grades R – 9 states the following:

Acceptance of a less rigid style of reporting of scientific investigations. For example, “I put a teaspoon of sugar in a glass of water and stirred it” should be equally acceptable to the more conventional “A spatula of sugar was placed in a beaker of water and stirred.”

Language is instead seen as something to be avoided; the RNCS for grades R – 9 (South Africa, 2003b:30) states:

Frequent use and acceptance of mind maps, flow charts, spider-grams, annotated drawings and the like instead of descriptions in words [emphasis mine]

Language (including the genres of science (McKeon, 2000) is seen as something to be taught by the English teacher. The RNCS (English) for grades 10 – 12 states the grade 10 learner should be able to:

identify and explain the purpose, structure and language use in texts across the curriculum such as reports, procedures, retelling, explanations, descriptions and expositions (South Africa, 2003a:28)

(4) The RNCS emphasizes the teaching of scientific and non-scientific texts. However, the RNCS states the teaching of non-scientific texts first, thus giving greater emphasis to the teaching of non-scientific texts than to the teaching of scientific texts; the RNCS (South Africa, 2002:14) for grades R – 9 states:

In the science classroom, this skill [communicating in the science classroom] may involve learners in forms of communicating such as giving oral reports in English or other languages, writing prose text, using an art form such as poetry or drama or comic strip, and using graphic forms such as posters, diagrams, pie-charts.

And, then the RNCS states:

Communicating also involves more conventional science forms such as tables, concept maps, word-webs, graphs, making physical, constructed models, or enacted models such as using people to show the motion of the planets around the Sun. (South Africa, 2002:14)

(5) The RNCS emphasizes the role of the teacher to be that of facilitator; the RNCS (South Africa, 2003c:5) for grades 10 – 12 states:

They will be able to fulfil the various roles outlined in the Norms and Standards for Educators. These include being mediators of learning [emphasis mine], interpreters and designers of Learning Programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors, and subject specialists.

‘Values’ are also addressed in the RNCS, as well as ‘The Manifesto on Values, Education and Democracy’. In the RNCS, ‘values’ forms one of three central themes, namely

‘values’, ‘knowledge’ and ‘skills’ to be ‘taught’ in the Further Education and Training (FET) Band. The RNCS for grades 10 – 12 states:

There is every reason to expect that the knowledge, skills and values [emphasis mine] people learn in the Physical Sciences will make even more of an impact on our lives as we move into the twenty-first century. (South Africa, 2003c:9)

The ‘kind of learner’ and the ‘kind of teacher’ envisaged in the FET Band is also expanded upon in the RNCS; for the ‘kind of learner’ envisaged the RNCS (South Africa, 2003c:5) states:

The kind of learner that is envisaged is one who will be imbued with the values and act in the interests of a society based on respect for democracy, equality, human dignity and social justice as promoted in the Constitution.

And for the ‘kind of teacher’ envisaged the RNCS (South Africa, 2003c:5) states:

The Revised National Curriculum Statements Grades 10 – 12 (General) visualizes teachers who are qualified, competent, dedicated and caring.

‘The Manifesto on Values, Education and Democracy’ emphasizes the following six values, namely ‘equity’; ‘tolerance’; ‘openness’; ‘accountability’; ‘honour’ and ‘multilingualism’. The six values and their meanings can be summarized as in *Figure 2.1.6-II* below:

VALUE	MEANING
Equity	“The importance of equity with an emphasis on redress, equal opportunity, and equal access.”
Tolerance	“Mutual understanding, reciprocal altruism and the active appreciation of the value of human difference.”
Openness	“Openness to new ideas and an orientation to knowledge based problem solving, critical thinking and debate.”
Accountability	“Educator and learner responsibility and excellence as well as the

Honour	legitimate and vibrant democratic governance of schools.” “A civic republican notion of citizenship whereby the needs of the individual and community are balanced; our sense of honour and identity as South Africans.”
Multilingualism	The fostering of multilingualism with an emphasis on the learner being trilingual.

Figure 2.1.6-II The six values named in the Values Report and their meanings as expressed in the Values Report (South Africa, 2000a; South Africa, 2000b:5)

The following extract is quoted from ‘The Manifesto on Values, Education and Democracy’ in the RNCS for grades 10 – 12; the RNCS (South Africa, 2003c:5) states:

Values and morality give meaning to our individual and social relationships. They are the common currencies that help make life more meaningful than might otherwise have been. An education system does not exist simply to serve a market, important as that may be for economic growth and material prosperity. Its primary purpose must be to enrich the individual and, by extension, the broader society.

‘Values’ are thus recognized as important in the RNCS, however, in addressing values as ‘values’, ‘knowledge’ and ‘skills’, values is treated as separate from knowledge and skills.

Finally, ‘progression’ is addressed in the RNCS. The RNCS uses the term ‘progression’ to refer to the notion of a developmental history; the RNCS for grades 10 – 12 (South Africa, 2003c:13) states:

Progression in this Learning Outcome [Learning Outcome 2: Constructing and Applying Scientific Knowledge] is ensured through increasing difficulty of concepts and the nature of contexts.

In addition, the RNCS for grades R – 9 describes the progression of the learner as the learner moves through the ‘Foundation Phase’ (grades R – 3); the ‘Intermediate Phase’

(grades 4 – 6); and the ‘Senior Phase’ (grades 7 – 9). As the learner in the ‘Further Education and Training Band’ (grades 10 – 12) is not discussed, what the RNCS has to say about the learner in the Senior Phase, considered out of these three phases to be the most appropriate to this study, is discussed instead.

The grade 9 learner is described in the RNCS as a learner who still largely uses language to construe experience and as a learner who is only beginning to use abstract language to reconstrue experience in a theoretical mode.

The RNCS (South Africa, 2002:45) states:

There is an increasing ability to generalize and construct principles which the learner applies to a variety of situations. By Grade 9, most learners are able to see that certain quantities are constant even when change takes place. For example, the learner understands that the mass of an amount of substance remains the same even if the shape of the substance changes or it is broken up.

In addition, the RNCS (South Africa, 2002:45) states:

Although the learner’s thinking is still dependent on personal experience of objects and situations, by Grade 9 some abstract thinking is taking place.

The description of the grade 9 learner in the RNCS thus places the learner in the region of the first and second stage as discussed in 2.1.4, i.e. ‘critical moment 1 and 2’, in the development of language in the individual.

In contrast, Halliday (2004e) places the grade 9 in the region of the third stage, i.e. ‘critical moment 3’, in the development of the language of the individual. Halliday (2004e) states thus that by grade 9 metaphorical language is predominately used to reconstrue experience.

There are thus inconsistencies in the manner in which progression is addressed in the RNCS and the literature that has been drawn upon in this study.

To conclude, during this time of curriculum reform, a competence and a performance model are said to be “jostling for dominance in the same reform” (Muller, 2000:105). At the center of this debate, Wells (1999) states, are the two main objects of education namely: (1) cultural reproduction; and (2) the development of individual students.

Cultural reproduction is promoted by those who emphasize teacher-led instruction, a centrally mandated curriculum, authoritative textbooks and standardized testing; this view states that creativity and originality are only possible once the learner has a firm grasp of the basic skills and the canon of knowledge taught by the school (Wells, 1999). In contrast, the development of individual students is promoted by those who emphasize learner-centered instruction with the teacher’s role being limited to that of a facilitator of learning; this view states that knowledge is individually constructed on the basis of the learner’s prior knowledge, interest and motivation (Wells, 1999). Wells (1999:227) states:

Characterized in these terms, it is not surprising that traditional and progressive education should be seen as polar opposites, nor that educational debate conducted from these positions should resemble a perpetual swinging of the pendulum from one side to the other.

A number of models of pedagogy in the literature recognize the partial validity of both of these positions: ‘an explicit pedagogy for inclusion and access’ (Cope and Kalantzis, 1993); ‘a Vygotskian model of social learning’ (Martin and Rose, in press); ‘a mixed pedagogy’ (Morais and Neves, 2001); ‘a sociocultural approach to teaching and learning’ (Wells, 1999) and the ‘developmental model’ (Christie, 2002). The ‘developmental model’ can be described as: (1) visible; (2) interventionist; and (3) to have “a relatively strong focus on the transmission of identified discourse competences and on the empowerment of otherwise disenfranchised groups in relation to this transmission” (Martin and Rose, in press:20). The theories that underpin the developmental model are situated in the lower right-hand quadrant in *Figure 2.1.6-III* below.

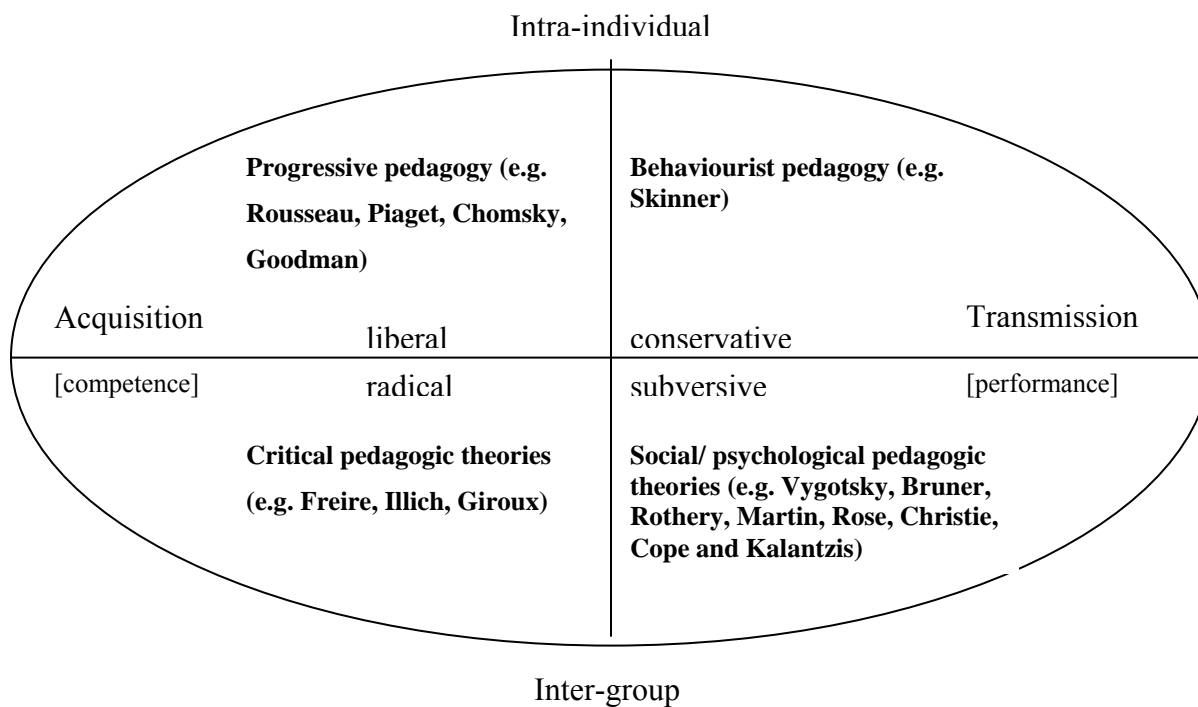


Figure 2.1.6-III Types of pedagogy (Martin and Rose, in press:20)

The theorists that situate themselves within the lower right-hand quadrant are, for example: Martin and Rose; Christie; Lemke; and Cope and Kalantzis. I have drawn chiefly upon these theorists in this study.

2.2 CLASSROOM WORK AS STRUCTURED EXPERIENCE

Lemke (1993) identifies a number of activities typical to the science classroom. These activities include ‘pre-lesson’ activities, ‘preliminary’ activities, ‘diagnostic’ activities, ‘main lesson’ activities and ‘interpolated’ activities. Lemke (1993) labels these activities as ‘Activity Types’.

Normally, only one Activity Type is going on in the science classroom at any given time. Transitions from one Activity Type to another are usually indicated by signal words, such

as ‘right’ or ‘now’, long pauses, and/ or metadiscourse⁷. The lesson as a whole can thus be described as ‘episodic’. (Lemke, 1993).

One of the Activity Types Lemke (1993) identifies is ‘Triadic Dialogue’. The Activity Type Triadic Dialogue is used in this study as “a principled basis for the selection of classroom texts” (Christie, 2002:22) in the interpretation and analysis of the data.

Triadic Dialogue is the most common Activity Type of a lesson (Lemke, 1993). Furthermore, Triadic Dialogue has a certain structure. Lemke (1993:4) states that “All social cooperation is based upon participants sharing a common sense of the structure of the activity: of what’s happening, what the options are for what comes next, and who is supposed to do what”. The structure for Triadic Dialogue can be represented as shown in *Figure 2.2* below with the moves that are optional in brackets and the moves that are obligatory in boldface.

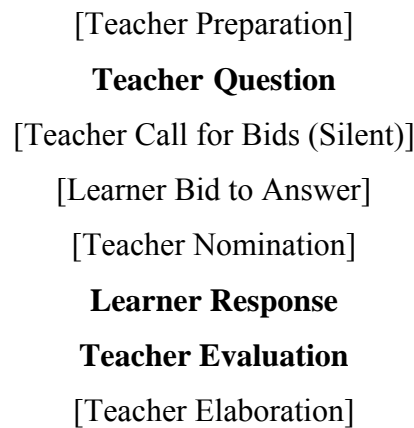


Figure 2.2 The moves for the Activity Type Triadic Dialogue (Lemke, 1993:8)

In Triadic Dialogue the move Teacher Question (also known as Teacher Initiation) is usually preceded by the move Teacher Preparation. Learners who do not connect Teacher Preparations and Questions are not in a good position to respond appropriately. Secondly,

⁷ Lemke (1993:227) defines metadiscourse as “Directly identifying or commenting on the structure or thematics of the discourse as a part of that discourse.”

the whole Bid and Nomination exchange is optional but when it does take place the move Teacher Call for Bids is usually not verbalized. Lastly, whatever the teacher does after the move Learner Response is considered an Evaluation (also known as Teacher Follow-up); however, Lemke states (1993), the teacher does have different options, such as giving a neutral evaluation, e.g. “Okay. Mbali. Thandi, do you agree or disagree?”, or a partially positive one, e.g. “Okay. That’s interesting. Who else has something that they would like to contribute?”. (Lemke, 1993).

The Activity Type Triadic Dialogue has been the subject of extensive discussion, and as such, has received much criticism; Edwards and Westgate (1994:29-53), for example, call for ‘real’ discussion; ‘conversational equality’ and for the teacher to ‘relinquish the normal role of the expert’ to foster a more ‘open’ classroom.

Wells (1999:168) states that at the centre of the debate is (1) the tension that exists within sociocultural theory between cultural reproduction and individual development, discussed in 2.1.6; and (2) “the somewhat undifferentiated manner in which triadic dialogue has typically been treated, as if all the occasions on which it occurs are essentially similar.”

The tension that exists within sociocultural theory between cultural reproduction and individual development and hence the tension that exists between the choice of an Activity Type typically associated with each of these, is evident in the context of South Africa; Probyn (2004:55) states:

South Africa introduced a new outcomes-based national curriculum in 1997 and the training for this has tended to cast teacher-centered practice as ‘traditional’ and to be abandoned in favour of ‘learner-centered’ approaches. This apparent dichotomy has not been helpful to teachers as it has undermined existing good practice and has left many teachers under the impression that the new curriculum requires groupwork activities to the exclusion of whole-class teaching.

Christie (2002) states that rather than rejecting Triadic Dialogue, the Activity Type is to be seen as one of the many Activity Types that make up a lesson if its value is to be determined. In addition, Christie (2002:5) states prior research on the Activity Type

Triadic Dialogue has often neglected to consider (1) the nature of meanings in construction; (2) the relative roles and responsibilities of the teacher and learners at the time of the construction of those meanings; and (3) the placement of the Activity Type within the larger cycle of classroom work.

Lastly, the importance of Triadic Dialogue as an Activity Type in the context of the South African classroom is recognized; Probyn (2004:58) states:

With the majority of learners in South Africa having to learn through the medium of a second language, more skillful front-of-class teaching might be necessary, through which the teacher can extend the learners' understanding and language skills, and provide a model and source of input of the target language.

It is for these reasons that I have chosen the Activity Type Triadic Dialogue as an Activity Type in which to investigate how the learners are inducted into science in the context of the South African science classroom.

2.3 CLASSROOM WORK AND THE THREE TYPES OF MEANING

Systemic Functional Linguistics (SFL) is used in this study as a model of discourse analysis. SFL recognizes meaning and use as central features of language. In SFL the grammar of a language is thus seen as (1) semantic, i.e. concerned with meaning; (2) functional, i.e. concerned with how language is used; and (3) a lexicogrammar, i.e. vocabulary (lexis) and grammatical choices are seen as inextricably linked. (Bloor and Bloor, 2004).

Christie (2002:11) states SFL theory is distinctive in at least three ways: (1) the 'metafunctional' organization of language; (2) the notion of 'system'; and (3) the relationship between text and context. The distinctive features of SFL are discussed below.

2.3.1 THE METAFUNCTIONAL ORGANIZATION OF LANGUAGE

SFL proposes that the grammar of a language reflects the functions for which language has evolved. Any language use serves to simultaneously negotiate relationships, construct experience and organize the language so that a satisfactory message is realized. The functions that operate simultaneously in the creation of meaning in relation to context are known as the three metafunctions. (Bloor and Bloor, 2004; Christie, 2002).

The three metafunctions are: (1) the interpersonal; (2) the ideational, consisting of the experiential and the logical metafunction; and (3) the textual metafunction. The three metafunctions can be represented as shown in *Figure 2.3.1* below.

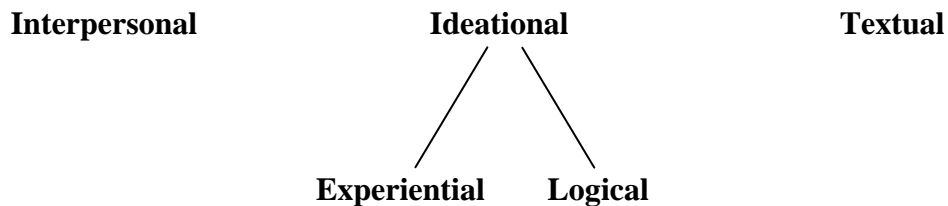


Figure 2.3.1 The three metafunctions with subfunctions (Christie, 2002:12)

The interpersonal metafunction, illustrated in 2.3.2, refers to those grammatical resources that enable us “to participate in communicative acts with other people, to take on roles and to express and understand feelings, attitude and judgements” (Bloor and Bloor, 2004:10).

The ideational metafunction, illustrated in 2.3.2, refers to those grammatical resources that enable us “to organize, understand and express our perceptions of the world and of our consciousness”. The subfunction or mode: the experiential is to do with “content” or “ideas” and the subfunction or mode: the logical is to do with “relationships between ideas” (Bloor and Bloor, 2004:10).

Lastly, the textual metafunction, illustrated in 2.3.2, refers to those grammatical choices that enable us “to relate what is said (or written) to the rest of the text and to other linguistic events” (Bloor and Bloor, 2004:11). In other words, it is to do with organizing the language as a message (Halliday, 1994).

2.3.2 THE NOTION OF SYSTEM

SFL proposes that language “operates through the exercises of clusters of choices or options”; in other words, language is polysystemic (Christie, 2002:13).

Language choices can be represented by a system network; the system network for the choices that are made from the grammar in the construction of an English clause is shown in *Figure 2.3.2-I* below.

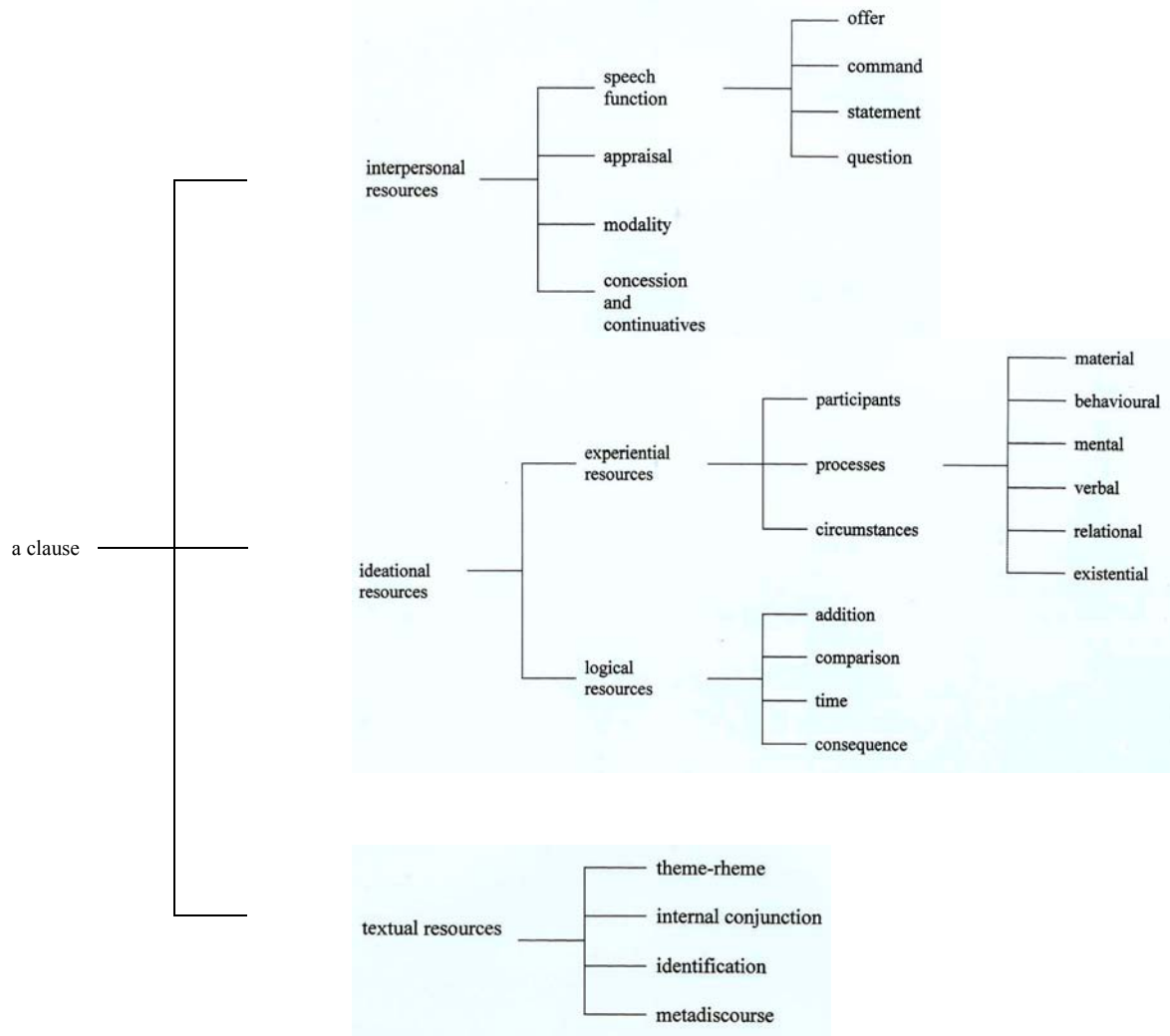


Figure 2.3.2-I A system network for the choices that are made from the grammar in the construction of an English clause (Bloor and Bloor, 2004; Christie, 2002; Eggins, 1994; Halliday, 1994; Martin, 1992 and Martin and Rose, 2003)

In a system network the first choice that is made is known as the least delicate choice. As the system network expands further and further to the right, i.e. as we ‘move in delicacy’, the choices that are made become progressively more delicate until the most delicate system is reached in which the most delicate choices are made, i.e. the range of choices become progressively less (Eggins, 1994:208). Whereas syntagmatic relations, i.e. “what elements from what classes can go next to each other in structures” (Eggins, 1994:204), are prioritized by formal grammatical approaches, it is evident from *Figure 2.3.2-I* that

paradigmatic relations, i.e. “what functional constituents stand in opposition to each other” (Eggins, 1994:204), are prioritized by SFL. In other words, a system network captures the logical structure of the system – “what contrasts with what” (Eggins, 1994:209). For example, in terms of the least delicate choices to be made for the system network in *Figure 2.3.2-I*, choices to do with ‘interpersonal’ resources stand in contrast to those to do with ‘ideational’ and ‘textual’ resources.

I have used the system network that is represented in *Figure 2.3.2-I* in the interpretation and analysis of the data in this study. In brief, it is evident from *Figure 2.3.2-I* that in the construction of an English clause simultaneous choices from the grammar are made with respect to the interpersonal, ideational and textual resources available to an individual (Christie, 2002). The ‘choices’ that are relevant to the interpretation and analysis of the data in this study are discussed below.

INTERPERSONAL RESOURCES

In the interpretation and analysis of the data the interpersonal resources of ‘speech function’; ‘appraisal’; ‘modality’; ‘concession’ and ‘continuatives’ are examined. In brief, these can be explained as follows.

(1) The four basic **speech functions** are offer, command, statement, and question. The desired responses to each of the speech functions are accepting an offer; carrying out a command; acknowledging a statement; and answering a question, respectively. The speech functions are defined by two variables, namely: (1) the speech role adopted by a speaker and hence the complementary speech role assigned to the listener; either giving or demanding; and (2) the nature of the commodity exchanged; either goods-and-services or information. The four primary speech functions are summarized in *Figure 2.3.2-II* below. (Halliday, 1994).

		INITIATION	EXAMPLE
<i>demand</i>	<i>goods-and-services</i>	command	‘Clean the board for me please.’
<i>give</i>	<i>goods-and-services</i>	offer	‘Who else would like to have a turn?’
<i>demand</i>	<i>information</i>	question	‘What sort of energy did the eraser have up there?’
<i>give</i>	<i>information</i>	statement	When a spring is pushed in tight it’s got the potential to expand and spring out.

Figure 2.3.2-II The four primary speech functions (Halliday, 1994)

(2) The resource of **appraisal** is to do with evaluation i.e. “the kinds of attitudes that are negotiated in a text, the strength of the feelings involved and the ways in which values are sourced and readers aligned” (Martin and Rose, 2003:22).

The basic options for appraisal can be summarized as shown in *Figure 2.3.2-III* below.

	EXAMPLES
<i>attitude:</i>	
<i>affect</i>	wish, happy
<i>judgment</i>	good, lucky
<i>appreciation</i>	beautiful, scientific
<i>amplification</i>	very, quite

Figure 2.3.2-III Basic options for Appraisal (adapted from Martin and Rose, 2003:24)

An example of appraisal is ‘scientific’ in ‘That one is more scientific.’⁸ where positive appreciation is expressed towards a statement made.

⁸ The example provided is one where the appreciation shown is evoked or implicit.

(3) The resource of **modality** sets up a ‘semantic cline’ between yes and no, i.e. a cline running between positive and negative poles (Halliday, 1994). The two types of modality are known as (1) modulation; and (2) modalization (Eggins, 1994). Modulation refers to “obligation or inclination of proposals” (Eggins, 1994:187). In other words, it is used for negotiating services, where demands for services can be negotiated as follows:

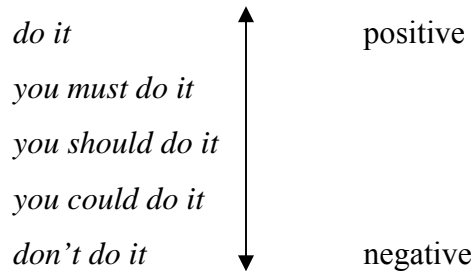


Figure 2.3.2-IV A ‘semantic cline’ for modalization (Martin and Rose, 2003:48)

An example of modulation is ‘You can’t just say fourteen newtons you must tell me the direction.’

In contrast, modalization refers to when modality is used to argue about “the probability or frequency of propositions” (Eggins, 1994:179). In other words, it is used for negotiating information, where statements that give information can be negotiated as follows:

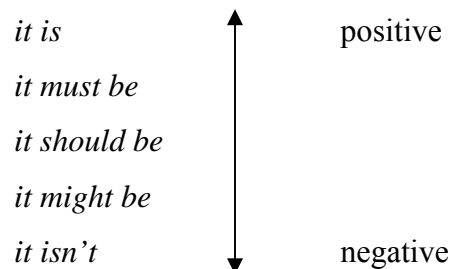


Figure 2.3.2- V A ‘semantic cline’ for modulation (Martin and Rose, 2003:48)

An example of modalization is ‘Sometimes you may have used that word energy due to position.’

(4) Lastly, **concessive resources** and **continuatives** adjust expectations (Martin and Rose, 2003). Concessive resources, e.g. ‘but’, counter expectations as in the following example: ‘But you said a force makes things to move. But you were wrong.’ Continuatives adjust expectations, e.g. ‘already’ indicates something takes place sooner than expected, as in the following example provided: ‘They know it already.’ A list of continuatives and the expectancy with which they are associated is summarized in *Figure 2.3.2-VI* below.

EXPECTANCY	EXAMPLES
<i>neutral</i>	too, also, as well
<i>neutral</i>	so (did he)
<i>less than</i>	only, just
<i>more than</i>	even
<i>sooner</i>	already
<i>longer</i>	finally, at last
<i>persistent</i>	still
<i>repetitive</i>	again

Figure 2.3.2-VI Continuatives (Martin and Rose, 2003:134)

EXPERIENTIAL RESOURCES

In the interpretation and analysis of the data the experiential resource of ‘transitivity’ is examined.

Transitivity is the grammatical system whereby all the ‘goings-on’ of our experience, namely happening, doing, sensing, meaning, and being and becoming, are sorted out in the grammar of the clause (Halliday, 1994:106).

The selections for transitivity are made in terms of the process types, namely: (1) material; (2) behavioural; (3) mental; (4) verbal; (5) relational; and (6) existential realized in verbal groups; participants, realized in nominal groups; and circumstances, realized in prepositional phrases or adverbial groups (Christie, 2002).

For example, in ‘I push the spring in tight.’, the process type for ‘push’ is ‘material’; the associated functional participant roles for ‘I’ and ‘the spring’ are the ‘agent’ and ‘goal’, respectively; and the prepositional phrase ‘in tight’ is a circumstantial of manner probed by asking ‘How?’ This can be represented as shown in *Figure 2.3.2-VII* below.

I	push	the	spring	in	tight.
Part: Agent	Pr: material	Part: Goal		Circ: manner	

Figure 2.3.2-VII Transitivity shown for the example ‘I push the spring in tight.’

The process types for transitivity can be summarized as follows:

(1) Firstly, **material** processes are processes of the “external world” (Halliday, 1994:107). For example: ‘A force is acting on the object.’

Behavioural processes are on the borderline between material and mental processes; they are processes “that represent outer manifestations of inner workings, the acting out of processes of consciousness and physiological states” (Halliday, 1994:107). For example: ‘We are going to talk about gravitational potential energy.’

(2) Secondly, **mental** processes are processes of “inner experience” (Halliday, 1994:107). Within the category of mental processes are the subtypes: (1) Cognition (verbs of thinking, knowing and understanding); (2) Affection (verbs of liking, fearing); and (3) Perception (verbs of seeing, hearing). For example: ‘All of you think of a spring.’; ‘We wanted to find the resultant of these two forces.’ and; ‘I heard the correct answer.’, respectively.

Verbal processes are on the borderline between mental and relational processes; they are processes to do with “symbolic relationships constructed in human consciousness and enacted in the form of language, like saying and meaning” (Halliday, 1994:107). For example: ‘Some books say energy is transformed.’

(3) Lastly, **relational** processes are processes of “classifying and identifying” (Halliday, 1994:107). For example: ‘Potential energy is energy due to height.’

Existential processes are on the borderline between relational and material processes; they are “processes concerned with existence...by which phenomena of all kinds are simply recognized to ‘be’ – to exist or to happen” (Halliday, 1994:107). For example: ‘There are two ways in which we can get the resultant.’

The process types can be represented as shown in *Figure 2.3.2-VIII* below.

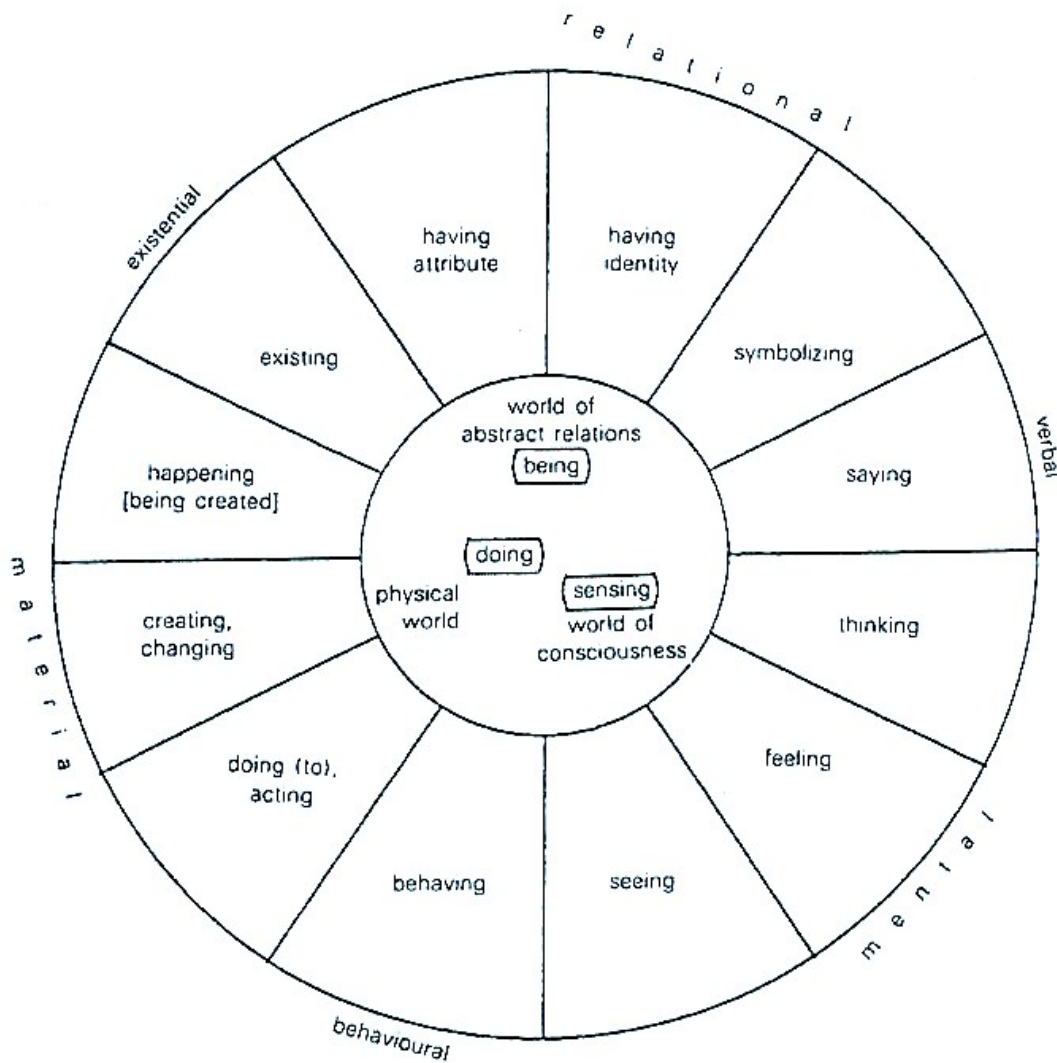


Figure 2.3.2-VIII The process types in English (Halliday, 1994:108)

LOGICAL RESOURCES

In the interpretation and analysis of the data I examine the logical resource of 'conjunction'.

Conjunction is to do with interconnections between processes, namely: (1) adding together; (2) comparing; (3) sequencing in time; and (4) explaining causes. Conjunction

is realized through wordings that include conjunctions, but also other kinds of wordings such as ‘continuatives’, e.g. too, only, even. (Martin and Rose, 2003).

A distinction is made between conjunction that connects activities, namely external conjunction, and conjunction that connects steps in an argument, namely internal conjunction. Internal conjunction is discussed further under textual resources. The major types of external conjunction are summarized below.

LOGICAL RELATION	EXAMPLES
<i>addition</i>	and
<i>comparison</i>	like
<i>time</i>	after
<i>consequence:</i>	
<i>cause</i>	because
<i>means</i>	thus
<i>condition</i>	if
<i>purpose</i>	in order to

Figure 2.3.2-IX Major conjunction types (adapted from Martin and Rose, 2003:133)

In addition, the major types of continuatives are summarized below.

LOGICAL RELATION	EXAMPLES
<i>addition</i>	too, also
<i>comparison</i>	only, just
<i>time</i>	already, finally

Figure 2.3.2-X Continuatives and logical relations (adapted from Martin and Rose, 2003:128)

TEXTUAL RESOURCES

In the interpretation and analysis of the data I examine the textual resources ‘theme/rheme’; ‘internal conjunction’; ‘reference’; and ‘metadiscourse’. In brief, these can be explained as follows.

(1) The **theme** of a clause is the first part of a clause, i.e. “that with which the clause is concerned”. The **rheme** is the remainder of the clause, i.e. “the part in which the theme is developed”. The theme-rheme boundary is indicated in the data interpretation and analysis using the symbol ‘#’. (Halliday, 1994:37).

Topical theme progression establishes connectedness and unity in a text when what appears as new information in the rheme of a clause becomes the topical theme in a subsequent clause (Christie, 2002:17). Theme progression is evident in the following example:

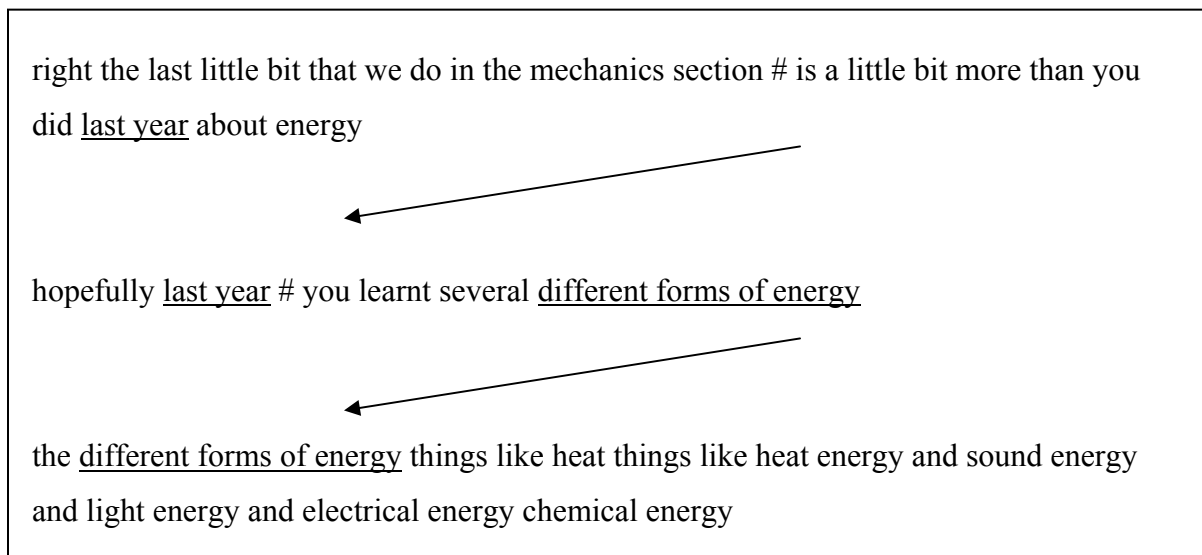


Figure 2.3.2-XI Theme progression

(2) The resource of **internal conjunction** is used to link logical steps internal to the text itself (Martin and Rose, 2003). In spoken discourse, conjunctions, such as ‘now’, ‘well’, ‘alright’, ‘okay’, are used to add new stages to what is being said, and others, such as ‘anyway’, ‘anyhow’, ‘incidentally’, are used to add a ‘sidetrack’ to the flow of discourse (Martin and Rose, 2003). In 4.1 – 4.4, each episode of triadic dialogue is divided roughly into stages according to internal addition.

(3) The resource of **identification** is to do with tracking participants, i.e. “introducing people and things into the discourse and keeping track of them once there” (Martin and Rose, 2003:145). The resources for identifying people and things can be summarized as follows:

TYPE	RESOURCES
<i>presenting</i>	a, an, one
<i>presuming:</i>	the, this, that
<i>possessive</i>	his, my, your
<i>comparative</i>	same, similar, other
<i>text</i>	this, that, it

Figure 2.3.2-XII Resources for identifying people and things (adapted from Martin and Rose, 2003:157)

The recovery of the identity of a presumed participant can be done in various ways depending on where the relevant information is (Martin and Rose, 2003). The types of reference, and where the types of reference refer to, can be summarized as follows:

REFERENCE	REFERS
<i>anaphoric</i>	backward
<i>cataphoric</i>	forward
<i>exophoric</i>	out to the situation

Figure 2.3.2-XIII Types of reference (adapted from Martin and Rose, 2003:161)

(4) Lastly, **metadiscourse** – to do with reference that is made to discourse as a thing or a process – is recognized as an important resource for ‘packaging discourse’ (Martin and Rose, 2003). An example of metadiscourse is ‘name’ in ‘Right. Can anybody remember another similar name for potential energy?’.

To conclude, SFL is used in the interpretation and analysis of the data to examine how the teacher and the learners exploit and deploy language choices to make meanings with respect to (1) power and control; (2) moral regulation; (3) social semiotic systems; and (4) a developmental history. The focus in Chapter 4 is thus on language as a resource, not as a set of rules. (Christie, 2002).

In addition, SFL is used to find the ways in which meanings, i.e. interpersonal, ideational and textual, are realized and tracked through the text. The goal in Chapter 4 is thus to interpret the meanings particular to the clause for their role in the overall organization of the text that the clauses constitute: A text may metaphorically be understood to function like a clause in having a configuration of meanings that are similar to the meanings of the clause (Halliday, as cited in Christie, 2002:35). SFL is thus “text- or discourse-driven”. (Christie, 2002:12).

2.3.3 THE RELATIONSHIP BETWEEN TEXT AND CONTEXT

The last of the features of SFL to be considered is the relationship between text and context.

Firstly, the impact of the immediate context of situation on the way language is used is described by register theory. The three dimensions of the situation identified as having significant and predictable impacts on the language use are the register variables of mode, tenor and field. These are to do with the “amount of feedback and role of language”; “role relations of power and solidarity”; and the “topic or focus of the activity”, respectively. (Eggins, 1994:9).

Secondly, the impact of the context of culture on language is described by genre theory. Genre theory explores “the staged, step-by-step structure cultures institutionalize as ways of achieving goals” (Eggins, 1994:9). This is illustrated in 2.2, where the ‘microgenre’ (Wells, 1999) Triadic Dialogue has become ‘institutionalized’ as a means of achieving certain educational goals.

Christie (2002) states that the relation between register and genre is as follows: As a genre unfolds register variables, such as the instructional and regulative register discussed in 2.1.2, help to construct the various stages. In other words, there are choices to do with field, tenor and mode. Although the choices to do with genre and register are not the same they are, however, mutually interdependent. Together, the choices build the text giving it its characteristic generic structure as well as particular values to do with the “amount of feedback and role of language”, “role relations of power and solidarity” and the “topic of focus of the activity”. (Christie, 2002 and Eggins, 1994:9).

Genre theory is adopted in this study for the following two reasons: Firstly, as discussed in 2.2, the ‘microgenre’ (Wells, 1999) Triadic Dialogue provides “a principled basis for the selection of classroom texts for analysis and interpretation” (Christie, 2002:22). And secondly, as discussed in 2.1.2, Christie’s adaptation of Bernstein’s notion of a pedagogic discourse, used to examine moral regulation in the interpretation and analysis of the data, is a principle which embeds two registers, namely a regulative register and an instructional register (Bernstein, 2000 and Christie, 2002).

CONCLUSION

In Chapter 2, I explained the theoretical framework that underpins this study.

In 2.1, the study was situated within a sociocultural framework and the principles that underpin sociocultural theory were outlined. These include the importance of the institution for cooperative human activity, the tools that members of a social organization possess to make sense of, and to those around them, and the multiple scales and time scales that human activity operates on.

The principles that underpin sociocultural theory were then related to the central concepts of the model of analysis used in this study to understand teaching and learning through the language of science, as well as the construction of the learner in the science classroom.

The central concepts of the developmental model include (1) power and control; (2) moral regulation; (3) social semiotic systems; and (4) a developmental history. In addition, the theories used to understand these concepts include (1) Bernstein's theory of classification and framing; (2) Christie's adaptation of Bernstein's theory of a pedagogic discourse; (3) Halliday's theory of Systemic Functional Linguistics; (4) Lemke's theory of the 'typological' and 'topological'; (4) Lemke's notion of values and ideology; and (5) Halliday and Matthiessen's theory of semogenesis.

Power and control, moral regulation, social semiotic systems, and a developmental history all play a role in the construction of the ideal pedagogic subject position, and the RNCS was examined in this section in terms of what it has to say about these issues.

In 2.2, I explained that the model of analysis used in this study draws upon the notion of genre theory as a "principled basis" (Christie, 2002:22) for the selection of data. The different moves of the microgenre Triadic Dialogue were discussed and the importance of

understanding teaching and learning that takes place through Triadic Dialogue in the context of the South African classroom was emphasized.

Finally, in 2.3, Systemic Functional Linguistics (SFL) was explained to underpin the model of analysis used in this study to investigate teaching and learning through the language of science at the micro level of classroom interaction. As explained in the Introduction this is necessary due to the need to move beyond understanding classroom practice in terms of the dichotomy of the traditional/ the progressive.

The features of SFL might be summarized as follows: the ‘metafunctional’ organization of language, the notion of ‘system’, and the relationship between text and context. The system network used in the interpretation and analysis of the data is depicted in *Figure 2.3.2-I*.

CHAPTER 3

METHODOLOGY

In Chapter 3 the decisions to do with the different dimensions of doing research into classroom practice in this study are explained; these include: (1) Conducting the preliminary study; (2) Formulating the research question; (3) Choosing discourse analysis as the principle mode of analysis; (4) Selecting the data; (5) Presenting the data; (6) Analyzing the data; and (7) Addressing validity threats.

3.1 THE PRELIMINARY STUDY

A preliminary study spanning a period of two weeks was conducted at three ‘township’ schools and an all-girls’ high school before the commencement of the study. The purpose of the preliminary study was to examine how teaching and learning took place through language in the science classroom.

Permission to do the preliminary study was negotiated with the assistance of my co-supervisor, Mr. Ngcoza, who knew some of the teachers personally and recommended them as suitably qualified and experienced. Letters requesting permission to undertake the preliminary study were sent to the principal and the physical science teacher at each of the four schools. During the preliminary study I observed grade 10, 11 and 12 science classes and discussed various matters with the teachers and learners, such as, the teachers’ experience of implementing Curriculum 2005. In addition, one lesson was videotaped and the first twenty minutes transcribed in order to closely examine the teaching and learning taking place at the micro level of classroom interaction.

From the preliminary study more was learnt about the following at each of the schools:

- (1) The ‘context of situation’ (Halliday, 1994) – the schools, the arrangement of the classrooms, the resources available to the schools;

- (2) The ‘context of culture’ (Halliday, 1994) – the nature of the pedagogic relationship for the different teachers and learners; and
- (3) The nature of the spoken and written texts produced by the teachers and learners, as well as the amount of time spent on ‘talking science’ (Lemke, 1993) and reading and writing.

Following the preliminary study, letters of thanks were sent to the teachers and two of the four teachers were selected for the study. The basis on which I selected these teachers, and their classrooms, as suitable contexts for doing research into the teaching and learning process is discussed in 3.4.

The dates for the study were then confirmed with these teachers, and letters requesting permission to do the study were sent to the principals, teachers and parents outlining the details of the study and reassuring them that their anonymity would be maintained. This was done in part to address the ethical issues that might arise from videotaping and transcribing the teachers’ and learners’ texts. The letters sent to the principals, parents and teachers are included in Appendix A, pp. 2 – 9. The letter sent to the parents is translated into isiXhosa as the majority of the parents are Xhosa first language speakers.

3.2 THE FORMULATION OF THE RESEARCH QUESTION

A sociocultural model of science education, as discussed in 2.1, is adopted in this study. Firstly, the adoption of a sociocultural model in this study has been influenced by current views of knowledge; Lemke (n.d.e:5) states:

The most sophisticated view of knowledge available to us today says that it is a falsification of the nature of science to teach concepts outside of their social, economic, historical, and technological contexts.

And secondly, the adoption of a sociocultural model has been influenced by the recognition of a need for more research to be done into the science classroom; Lemke (n.d.g:4) states:

The organized efforts of many people in our field today are focused on setting curriculum achievement standards and promulgating more intellectually authentic teaching methods, but more basic institutional, social, cultural, and linguistic prerequisites for school success are still not being taken seriously enough.

Research into the basic institutional, social, cultural and linguistic prerequisites for school success is particularly pertinent to the South African science classroom which is in a current state of curriculum reform.

As a result of adopting a sociocultural model, the school or more specifically the science classroom, has been viewed as “social activities”. In other words, “the role of social interaction in teaching and learning science and in studying the world” has been taken into cognizance, in the formulation of the research question, namely: “How are these learners apprenticed to be science learners and what is the ‘ideal pedagogic subject position’?” (Lemke, n.d.e:1).

3.3 DISCOURSE ANALYSIS AS THE PRINCIPLE MODE OF ANALYSIS

Research that goes beyond “the dichotomies of open/ closed school, visible/ invisible pedagogies, and discovery learning/ reception learning” needs to introduce “a dimension of great rigour into teacher’s pedagogic practices” (Morais and Neves, 2001:215).

Discourse analysis, and in particular SFL as a model of discourse analysis, provides the tools for the research conducted in this study into teacher’s pedagogic practices to be rigorous. Christie (2002:24) states:

I would argue that a grammatical analysis as delicate as that provided by the SF grammar allows a very fine interpretation of the meanings made and the nature of the relationships of participants in the discourse. That method of grammatical analysis, together with the genre theory that it illuminates can also assist in development of a more general theory of pedagogic practices.

Secondly, discourse analysis conducted within the theoretical framework provided by Bernstein (2000), and as adapted by Christie (1997; 2001 and 2002) for the classroom, provides the tools for the research conducted in this study to (1) Reveal the manner in which pedagogic knowledge and relationships are constructed; and (2) Allow judgements to be made about the relative success of the different models of pedagogy and of the pedagogic subject that seem to apply (Christie, 2002:25).

As different models of pedagogy are likely to be operating at a time of curriculum reform, to be able to make judgements about the relative success of the different models seems to be particularly pertinent. In addition, as the different models of pedagogy that are likely to be operating bear relation to current changes in policy, to be able to understand the relation between practice and policy too seems to be pertinent. Lemke (1998a:1186) states:

They [the methods of discourse analysis] make possible rich descriptions of the lived curriculum, its relation to official curriculum plans, and to the web of intertextuality among all the spoken and written language in which education is framed.

However, although certain ‘revelations’ to do with teaching and learning in the South African science classroom are made in this study, discourse analysis as any other instance of discourse is just as viewpoint dependent (Lemke, 1998a:1186). Christie (2002:22) states:

Discourse itself is never neutral, and discourse analysis is also not neutral, for it necessarily involves the imposition of some interpretation upon events. Indeed, the very transcript of the classroom talk (and the video record from which that is drawn), is already removed from the reality, and itself an interpretation of it.

Discourse analysis is therefore always an interpretation (Lemke, 1998a:1186) which needs to be taken into consideration upon examination of the conclusions drawn in this study.

Lastly, SFL as a canonical procedure of discourse analysis most importantly provides common ground for other researchers to enter into the discussion and to systematically compare the “many interdependent grounds of their respective interpretations” with the interpretations to do with teaching and learning in the South African science classroom made in this study irrespective of whether or not common consensus is reached (Lemke, 1998a:1184-1186).

To conclude, discourse analysis as the primary means of analysis in this study provides the tools for understanding what exactly is going on in the texts that are chosen to be analyzed in terms of (1) power and control; (2) moral regulation; (3) social semiotic systems; and (4) a developmental history in the interpretation and analysis of the data in Chapter 4. This, Lemke (1998a) states, although it will not tell us a lot about how all science classrooms or all science writing is alike, is as much as any theory does in practice.

3.4 SELECTION OF THE DATA

Researcher-controlled recontextualization⁹ of the data that takes place through the process of the selection of data, as well as the presentation of data, is a “critical determinant” in terms of the information content of the data (Lemke, 1998a:1176).

Recontextualization in this study takes place when the language of the science classroom is transposed from the activity in which it originally functioned to the activity in which it is analyzed as research data in Chapter 4. This displacement depends on such processes as the selection and presentation of the data in which the work performed in doing such, plays an important role in shaping the data. Data, Lemke (1998a) states, thus has to become part of the manner in which we construe the world before it can become analyzable. (Lemke, 1998a).

⁹ The notion of ‘recontextualization’ is discussed in 2.1.2.

The criteria for the selection of data in this study were that (1) The action should take place in the science classroom (2) The dialogue should take place in the context of the Activity Type ‘Triadic Dialogue’; and (3) The four texts should have to do with the four central concepts of the developmental model, namely: power and control, moral regulation, social semiotic systems and a developmental history, as discussed in 2.1.

Firstly, data generation in this study took place in the context of the science classroom. The generation of data in the classroom, as opposed to the research laboratory, is recognized as important in sociocultural theory. Lemke (1998a:1185) states:

The essential context-sensitivity of meaning-based phenomena (meaning *is* selective contextualization) suggests that, if we are in a classroom phenomenon, we should study it *in situ*.

In other words, as discussed in 2.1, in line with current models of ‘situated cognition’, meaning-making processes are dependent on, not independent of, local contexts and ‘cognition’ is a process that includes the individual’s tools and the elements of the environment with which it interacts, not a system limited to the individual itself (Lemke, 1998a).

The resources and strategies used in producing discourse events and texts in the science classroom are thus assumed by discourse analysis to be characteristic of the science classroom; Christie (2001:316) states:

I was struck by the marked differences in the discourses depending upon: the school discipline, the physical locations where the episodes occurred and the ways other semiotic systems apart from language were involved in the construction of the activity. All these affected the language and the literacy.

In addition, the resources and strategies used in producing discourse events and texts in the science classroom are assumed by discourse analysis to be characteristic of a particular science classroom, rather than unique to an event in that classroom; i.e. the

discourse events and texts are part of that classroom's general cultural resources and as a result differ from one classroom to the next (Lemke, 1998a); Lemke (1998a:1185) states:

...what it means to have a culture is that we preferentially deploy some of these resources in some contexts rather than others; how we *use* the resources is essentially context dependent.

A grade 10 bilingual physical science classroom in a 'township' high school in the Eastern Cape is the community of interest in this study. Lemke (1998a) points out that discourse analysis studies are often best when they study a particular community in depth. Research into this community is significant, in particular in the context of South Africa, for the following reasons:

- (1) The pass rate in physical science is low. Muller (2000:66) states "In South Africa, one of the most glaring indices of the depth of the racial divide in the education system is the failure of Black children in mathematics and science programmes at all levels."
- (2) Curriculum 2005 was implemented for the first time in grade 10 this year in 2006.
- (3) The 'middle' years of schooling have received little attention in terms of research in South Africa, even though current research shows that it is "the key to national innovation" (Muller, 2000:35).

In addition to the generation of data from the grade 10 physical science classroom, data has also been generated from (1) a grade 11 physical science classroom taught by the same teacher in the 'township' high school; and (2) another grade 10 physical science classroom in an all-girls' high school. The criteria for the selection of the teachers and their learners in this study are (1) the teacher's qualifications and experience - both teachers are well qualified and highly experienced; and (2) the majority of the learners are bilingual learners. Information concerning the teachers' particulars and the percentage of bilingual learners in each class is provided later in *Figure 3.4-I* and *Figure 3.4-II*. The grade 10 physical science classroom in the all-girls' high school and the grade 11 physical science classroom form an integral part of this study for the following reasons:

- (1) The basis of aggregation is ‘covariation’ between text features and context features (Lemke, 1998a). In other words, an examination of the ‘covariation’ that exists between multiple texts produced in different or similar contexts is necessary to build up a picture of the teaching and learning process.
- (2) The basis of discourse analysis is comparison (Lemke, 1998a). Lemke (1998a:1176) states “If you are interested in covariation between text features and context features, you should *not* collect data *only* for the cases of interest, but also for cases that you believe will stand in contrast with them.” (Lemke, 1998a:1176).
- (3) And the fourth central concept of the developmental model, namely ‘a developmental history’, will either present itself as absent or present when examined across the grades, i.e. grades 10 and 11 in this study, in the Further Education and Training (FET) band.

Information concerning the teachers and context of this study can be summarized as shown in *Figure 3.4-I* and *Figure 3.4-II* below.

SCHOOL	TEACHER	GRADE	LEARNERS
Mfundo High*	Mr. Maletso	grade 10	all bilingual learners (Xhosa ¹⁰ / English)
		grade 11	all bilingual learners (Xhosa/ English)
Greensborough High	Mrs. McKenzie	grade 10	20 out of 26 learners bilingual (19 Xhosa/ English) (1 English/ Afrikaans)

* The names given to the schools and teachers are pseudonyms

Figure 3.4-I The schools and their respective teachers and learners

¹⁰ isiXhosa is the home language of 83.8 per cent of the population living in the Eastern Cape; those who speak English as a home language in the Eastern Cape, by comparison, constitute 3.7 per cent of the population (South Africa, 2003d:16).

	QUALIFICATIONS	YEARS TEACHING EXPERIENCE IN SCIENCE
Mr. Maletto	M.Ed. in Science Education Teacher's Diploma	30+
Mrs. McKenzie	B.Sc. Honours Teacher's Diploma	30+

Figure 3.4-II The teachers and their qualifications and years teaching experience in science

Lastly, the primary sources of data in this study are:

- (1) Classroom non-participant observation;
- (2) A journal kept throughout this study;
- (3) Document analysis of the RNCS, teachers' notes, handouts, the learners' notebooks, and the textbook(s) used by the teachers and learners; and
- (4) Analysis of the classroom interaction.

Classroom non-participant observation took place over the first and second term of the school year. In conjunction with the preliminary study Mr. Maletto and his learners were observed for ~15 lessons whereas Mrs. McKenzie and her learners were observed for ~10 lessons. As a number of lessons were observed (more than 25 lessons) and as these lessons were observed over an extended period of time before, during and after the analysis of the data, a picture was built up of the three classrooms. Stubbs (1976) states that if the inherent complexity of meanings that develop between speakers over long periods of time are not to remain hidden, an understanding of the classroom in which data is generated is important.

The lessons I videotaped for the purposes of this study can be summarized as shown in *Figure 3.4-III* below. The lessons have been labeled as Lessons A – I. In addition, the transcripts of these lessons have been labeled as Transcripts A – I; Transcript A is thus

for Lesson A, and so forth. The presentation of the data in the transcripts is explained further in 3.5.

Mr. Maletto	Mrs. McKenzie	Mr. Maletto
Grade 10	Grade 10	Grade 11
Lesson A February*	Lesson F April	Lesson H May
Lesson B April	Lesson G April	Lesson I May
Lesson C May		
Lesson D May		
Lesson E May		

* Videotaped during the preliminary study

Figure 3.4-III The lessons videotaped for the purposes of this study

The duration of each of the lessons for Mrs. McKenzie is ~45 minutes. The duration of each of the lessons for Mr. Maletto is ~40 – 60 minutes¹¹. The decision to videotape the lessons was taken, firstly, because preliminary research revealed that there was less background noise than when the lessons were audiotaped (The video recorder had a built-in zoom microphone); and secondly, because videotaping allows the multiple ways in which meaning is made in the science classroom to be captured. Lemke (1998a:1177) states:

Videotapes obviously contain a wealth of relevant visual information on gaze direction, facial expression, pointing and other gestures, contextual artifacts referred to in the verbal text, positional grouping, relative distances and directions.

The second source of data, namely the journal kept throughout this study, has been used to record and reflect upon:

¹¹ The lessons at Greensborough High were consistently ~45 minutes in duration whereas the duration of the lessons at Mfundo High varied; time therefore seemed to play a larger role in the overall structure of the school day at Greensborough High than Mfundo High.

- (1) The lessons observed and videotaped.
- (2) The conversations that took place before and after lessons observed with Mr. Maleto, Mrs. McKenzie and the learners. Wells (1999:263) states that if the reason why a teacher selects one follow-up option/ 'microgenre'/ task/ activity rather than another is to be understood an understanding of "the individual teacher's conception of teaching and learning that guides his or her behaviour at every level" is important.
- (3) The difficulties faced and decisions made in the generation, presentation and analysis of the data.

Examples of entries made in the journal are included in Appendix A, pp.10 – 13.

The third source of data, namely the document analysis of the RNCS, teachers' notes, handouts, the learners' notebooks, and the textbook(s) used by the teachers and learners, has been used to inform the analysis and interpretation of the data. Christie (2001:314) states that curriculum documents, classroom handouts and learners' notes are "essential in judging the language and literacy demands in the school disciplines". In addition, Lemke (1998a) states that if a researcher is interested in the language of a particular kind of event or text, the event or texts' relevant 'intertexts', such as the RNCS in this study, should also be collected due to the contextual nature of discourse analysis.

Lastly, the fourth source of data, namely the analysis of the classroom interaction is discussed in 3.6.

The second dimension to this study in which data selection plays a role, as mentioned previously at the beginning of this section, is to do with the Activity Type 'Triadic Dialogue' in which discourse plays a 'constitutive' (Christie, 2002) role.

The distinction between matters that are 'ancillary' to, or 'constitutive' of, language is useful for pedagogic purposes for making selections of classroom texts for interpretation and analysis; Christie (2002:152) states:

...one will always need to make choices about which aspects of semiosis [i.e. meaning-making] will be the major focus of attention: whatever one does, it will always be a selection, and one can never describe the lot.

In addition, the notion of an Activity Type, as discussed in 2.2, is useful as a “principled basis” for making selections of classroom texts for interpretation and analysis (Christie, 2002:22).

Language is thus the principle social semiotic system of interest in this study. The importance of language as a social semiotic tool in the classroom is recognized in the literature. Christie (2002:2-3) states:

...unless we are willing to engage seriously with the discourse patterns particular to the institution of schooling, then we fail genuinely to understand it...It is in language, after all, that the business of schooling is still primarily accomplished whether that be spoken or written and, even though language is to be understood not as some discreetly independent entity, but rather as part of complex sets of interconnecting forms of human semiosis.

And Lemke (1993:123) states:

Talking science is not the totality of doing science. But very little science gets done, or could get done, without the semantic resources of language, and particularly the thematic patterns and genre structures specific to science.

In addition, as discussed in 2.1.3.1, the importance of mathematical and visual literacies for communication in the science classroom is also recognized in the literature; “The “concepts” of science are not verbal concepts, though they have verbal components. They are semiotic hybrids” (Lemke, 1998b:3). Language as a social semiotic tool in this study thus includes all the ‘languages’ (Lemke, n.d.b) of science.

Christie (2002:152) states that “the scholarly work to be done in teasing out and describing the relationships of written texts and diagrams, maps and illustrations, at least for pedagogic purposes, has only just commenced”. A need for research to be done into

the multiple literacies and genres of the classroom thus exists; Lemke (2000) states that this need extends to research into the multimodal literacies and genres: (1) for each specific curriculum subject; (2) at each grade level; and (3) in terms of how individuals integrate multiple literacies. Research into the integration of multiple literacies, Lemke (2000:269) states, is beginning to take place with the simplest forms of reading and writing, however, it is “far too narrow and idealized a view of what literacy-in-practice actually involves” – “Literacy in the real world, as in the advanced curriculum, is always multiple and integrated”.

The scientific curriculum, due to the large number of multiple literacies that are employed, is recognized to be an ideal place to begin the specification of the relevant and multiple literacies of the classroom in detail (Lemke, 2000).

Finally, data selection in this study takes place through the selection of four texts to do with the four central concepts of the developmental model.

Verbal language is recognized to present certain challenges not normally encountered when examining written language (Christie, 2002; Lemke, 1993; 1998a; Martin, 1992; Stubbs, 1976 and Westhoff, Martin and Rose, working draft, March 2004). Stubbs (1976:75) states:

One reason, then, why, researchers have fought shy of studying classroom interaction is the notorious complexity of communicative behaviour. But complexity will not dissolve if we ignore it.

And Christie (2002:98-99) states:

I am also of the view that if we are really to understand the nature of teaching and learning, and in particular to interpret how teachers manage to effect important changes in their students’ understanding, we must be bold enough to view the relatively ‘big sweep’ of classroom talk that typically characterizes a unit of curriculum activity.

The following are provided by Christie (2002) as challenges faced by researchers who do research into verbal language in the classroom:

- (1) Capturing of all that is said in the classroom, even with the best recording equipment.
- (2) Recording a unit of work that might possibly run for a full school term of ten weeks.
- (3) And, in particular, selecting texts so that they can be presented, analyzed and interpreted.

The ‘classic problem’ in the selection of texts, or textual structure, is recognized to be ‘segmentation’ (Lemke, 1998a:1183); Lemke (1998a:1183) states:

The boundary, particularly of a large, high-ranking unit (e.g., genre stage, rhetorical move) can be indeterminate in terms of lower-level grammatical or word units because it is defined by several simultaneous criteria, each of which results in drawing the boundary at a slightly different place in the text. As a general rule, units of *meaning* can have fuzzy boundaries in terms of *form* (or even in terms of units of meaning at a different level of analysis).

In addition, Wells (1999) states that analysts frequently experience difficulties as they attempt to segment verbal data into episodes because the goals of a lesson are progressively negotiated as events unfold resulting in boundaries that are not clear-cut; Wells (1999:253) states “the transition to a “new” action unit may only be recognized, by participants as well as by analysts, as having occurred some moments after it was initiated by those who were most responsible for bringing it about”.

For example, ‘segmentation’ seen in terms of the moves for the Activity Type Triadic Dialogue, as discussed in 2.2, poses the following challenge in this study: “When does an extended move, such as Teacher Preparation, no longer function as a move in the Activity Type Triadic Dialogue but as a new Activity Type, such as Teacher Monologue?”¹²

¹² The ‘segmentation’ of the nine lessons transcribed, according to the different Activity Types, can be found in Appendix B (pp.14 – 147).

The lessons, namely Lessons A – I, are therefore largely segmented into the different Activity Types recognized by Lemke (1993), as discussed in 2.2, by recognizing the start of a new Activity Type due to a change in topic; Lemke (1998a:1183) states “The way in which most texts maintain their coherence is largely by topic continuity or, more generally, by maintaining cohesion chains, whose members have no consistent structural-functional relations.”

For example, the first text analyzed – Triadic Dialogue 8A¹³ (the eighth Activity Type recognized for Lesson A) – is to do with the topic ‘force’. Triadic Dialogue 8A maintains its coherence by maintaining topic continuity, i.e. the topic ‘force’, despite being interrupted twice to explicitly address language and twice for the performance of a demonstration. At times, as in the first text analyzed these ‘interruptions’ were chosen to be analyzed in depth as they form part of the moves Teacher Preparation and Teacher Elaboration. However, at times these ‘interruptions’ were chosen not to be analyzed in depth in particular when the overall text was deemed to be excessively long, i.e. each text was selected so as to be in the region of 200 clauses or less in length for the analysis of the text using SFL to be manageable. The context for Triadic Dialogue 8A can be represented diagrammatically as shown in *Figure 3.4-IV* below.

¹³ The transcription for Triadic Dialogue 8A can be found in Appendix B (pp.21 – 24).

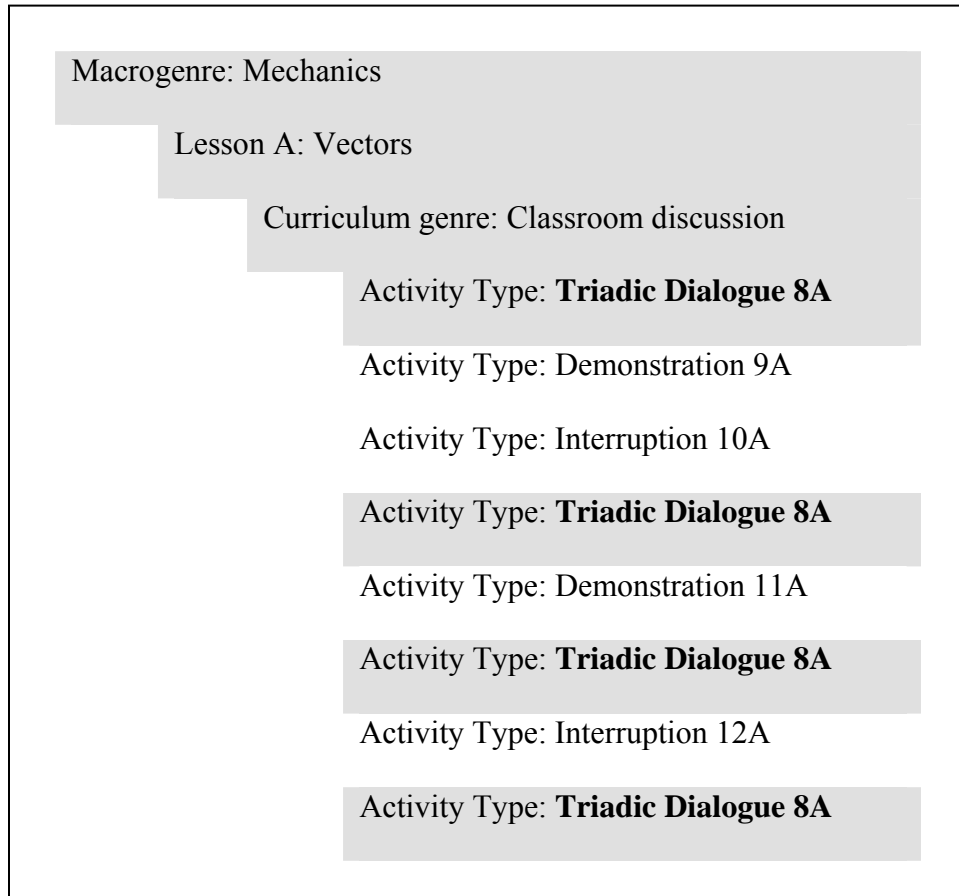


Figure 3.4-IV The context for the eighth Activity Type for Lesson A, namely Activity Type 8A

Unpacking *Figure 3.4-IV*, Triadic Dialogue 8A might be said to be embedded within the ‘curriculum genre’ (Christie, 2002) classroom discussion which in turn is embedded within Lesson A and the larger unit of work or ‘macrogenre’ (Christie, 2002) mechanics. The details for Triadic Dialogue 8A, as well as the other texts chosen to be analyzed in Chapter 4, namely: (1) Triadic Dialogue 9F (the ninth Activity Type recognized in Lesson F); (2) Triadic Dialogue 1B (the first Activity Type recognized in Lesson B); and (3) Triadic Dialogue 4H (the fourth Activity Type recognized in Lesson H), are shown in *Figure 3.4-V* below.

TEXT	TEACHER	LEARNERS	TOPIC
8A	Mr. Maletto	Grade 10	Force
9F	Mrs. McKenzie	Grade 10	Mechanical energy
1B	Mr. Maletto	Grade 10	The addition of vectors
4H	Mr. Maletto	Grade 11	Forces in equilibrium

Figure 3.4-V The details of the four texts selected for interpretation and analysis in Chapter 4

Triadic Dialogue 8A – 4H have been chosen for the following reasons:

- (1) In Triadic Dialogue 8A it is evident that the features characteristic of a performance based model and a competence based model, as discussed in 2.1.6, are at play.
- (2) In Triadic Dialogue 9F it is evident that Scientific English poses challenges due to its ambiguous nature; in addition, it is evident that verbal language differs to some degree from one community to the next.
- (3) In Triadic Dialogue 1B it is evident that multiple literacies, i.e. verbal (and written), mathematical and visual literacies, need to be integrated “quickly and fluently in real time” in the FET band (Lemke, 2000:247).
- (4) And in Triadic Dialogue 4H it is evident that a ‘developmental history’ is at times present and at times absent for the unit ‘mechanics’ across the grades 10 and 11; in addition, language learnt in grade 10 plays a role in the grade 11 classroom.

Although these features, namely: the characteristics of a competence and performance model, the ‘languages’ of science, and a ‘developmental history’, are evident in all the texts analyzed they are most noticeable in the texts in which they are foregrounded during the analysis. For example, in Triadic Dialogue 1B, the teacher and learners solve a problem in which verbal, mathematical and visual literacies are used, whereas in Triadic Dialogue 9F the teacher and learners solve a problem in which verbal language predominates.

The concepts of the developmental model foregrounded in Triadic Dialogue 8A – 4H, together with the theories used in the analysis of each of the texts, are shown in *Figure 3.4-VI* below.

TEXT	CONCEPT OF THE DEVELOPMENTAL MODEL	THEORIES USED IN THE ANALYSIS
8A	Power and control	Classification and framing
9F	Moral regulation to do with acceptably ‘good’ behaviour and verbal language	The pedagogic discourse involving a moral regulation and the construction of an ‘ideal pedagogic subject position’
1B	Moral regulation to do with multiple literacies	The pedagogic discourse involving a moral regulation and the construction of an ‘ideal pedagogic subject position’
4H	A developmental history	Logogenesis

Figure 3.4-VI The concept of the developmental model foregrounded in each of the four texts and the theories used in the analysis and interpretation of the data

It is thus evident that situating this study within sociocultural theory has implications for the selection of texts for interpretation and analysis in Chapter 4. Selection of texts for discourse analysis is thus not governed by random sampling; instead selection of texts is governed by the purposes of the researcher which are made known (Lemke, 1998a:1176). Christie (2002:23) states:

Methods and models of analysis of talk are actually built on theories of human behaviour and society, whether acknowledged or not, and these have consequences for the text selections that are made, as well as the interpretations offered of them.

However, although four texts have been chosen for analysis and interpretation in Chapter 4, this analysis is informed by the whole text, namely Lessons A – I; Christie (2002:23) states:

Even where...one cannot reproduce a complete classroom text, one must collect and analyse the whole text (or as much of that as is feasible), so that what one says of those passages selected for presentation and discussion is informed by an analysis and interpretation of the whole text.

The analysis of the whole text is discussed further in 3.6.

3.5 PRESENTATION OF THE DATA

In presentation of the data as written language different expectations and perceptions are created (Lemke, 1998a); Lemke (1998a:1176) states:

What sounds perfectly sensible and coherent can look in transcription (*any* transcription) confused and disorganized. What passes by in speech so quickly as not to be noticed, or is replaced by the listener's expectations of what should have been said, is frozen and magnified in transcription.

In addition, in presentation (and analysis) of the data through the process of transcription information from the original data is discarded as features of interest are brought to the fore, i.e. discourse analysis, as with all analysis, is 'reductive' (Lemke, 1998a). The relation between the new text created and the original data therefore needs to be considered in terms of what has been preserved, lost and changed (Lemke, 1998a).

The presentation of data in this study is to do with (1) Transcripts A – I; (2) Transcripts J – M; and (3) the transcriptions presented in Chapter 4.

Firstly, Transcripts A – I, as discussed in 3.4, are for Lessons A – I, respectively. The details for Lessons A – I can be summarized as shown in *Figure 3.5-I* below.

	TEACHER	GRADE	TOPIC
A	Mr. Maletto	10	The vectors displacement, velocity, acceleration and force
B			Addition of vectors in a straight line
C			Addition of vectors acting at an obtuse angle and at 90°
D			Addition of vectors acting in a straight line and at 90°
E			An example for the addition of vectors
F	Mrs. McKenzie	10	Mechanical energy and the vector force
G			Mechanical energy and the vector force
H	Mr. Maletto	11	Forces in equilibrium
I			An activity for forces in equilibrium

Figure 3.5-I Lessons A – I

Lessons A – I are transcribed at the ‘lexical’ level, i.e. sequences of “whole, meaningful words” and “meaningful non-lexical vocalizations” have been preserved (Lemke, 1998a:1177); in addition, in the transcription of Lessons A – I the written, mathematical and visual literacies, constructed on the chalkboard or shown on the Overhead Projector (OHP) during the lesson, have been included.

The transcription of Lessons A – I at the ‘lexical’ level, and the inclusion of the multiple literacies employed during the lesson integral to communication in the science classroom (Lemke, 2000), has been done for the purpose of the analysis of the whole text which, as discussed in 3.4, is to inform the analysis of the four texts selected. The analysis of the whole text is discussed further in 3.6.

An example of a transcription for Lessons A – I, included in Appendix B (pp. 14 – 147), is shown in *Figure 3.5-II* below.

ACTIVITY TYPE: 'review' cont.; 'microgenre' 'IRF'

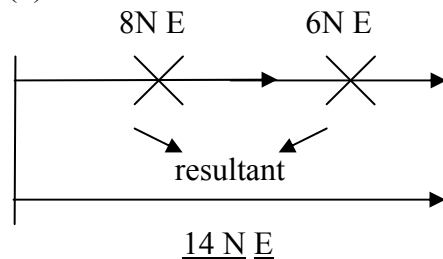
FIELD:

Problem 1 – vectors acting in the same direction

Method 1 and 2 for solving problem 1 and 2 – 'calculation'/ 'drawing and measurement' (scale drawing)

1.40B T now we said okay now if [unclear] now we stopped here we said that you
1.41B can add vectors acting in the same direction so we have same direction and
1.42B we said here this is the same as what as angle between vectors is what
1.43B equals zero right zero degrees okay the angle between the vectors is now
1.44B equal to zero degrees [chalkboard (6)]

(6)



same direction
angle between vector = 0°

Figure 3.5-II An example of a transcription for Lessons A – I

The information included and/ or the conventions of transcription for Lessons A – I are as follows:

- (1) The segmentation of the lesson into the different Activity Types (Lemke, 1993);
- (2) The topic or 'field' (Halliday, 1994) for each Activity Type included at the start of each Activity Type;
- (3) The Activity Type of interest to this study, namely Triadic Dialogue, shaded in grey; and
- (4) Each line of the text coded for ease of reference in Chapter 4; for example: the line of text 'equal to zero degrees' is coded as 1.44B, where '1' stands for the first Activity Type of the lesson, '44' stands for the forty fourth line of text and 'B' stands for Lesson B or Transcript B.

Secondly, Transcripts J – M, included in Appendix C (pp. 148 – 244), are for the four texts selected for more intensive analysis, namely Triadic Dialogue 8A, 9F, 1B and 4H, respectively.

The system of transcription used for Triadic Dialogue 8A – 9F is a system of transcription proposed by Dressler and Kreuz (2000) based upon a 5-year survey on the systems employed in articles appearing in the journal ‘Discourse Processes’.

The transcription of Triadic Dialogue 8A – 9F using the system of transcription proposed by Dressler and Kreuz (2000) preserves information beyond the ‘lexical level’; Lemke (1998a:1177) states:

The simplest transcriptions attempt to preserve information at the level of the word, but language only occasionally constructs meaning with single words. What matters is how the words are tied together, and that often includes intonation contours... Transcription at the level of the word also erases information about emphasis, value orientation, degree of certainty or doubt, attitude of surprise or expectability, irony, humour, emotional force, speaker identity and speaker dialect or language background... In addition, information about timing of speech (length of pauses, simultaneous speech, sudden breaking-off of fluency, overlaps, etc.) is frequently important.

The information and/ or conventions of transcription included in the transcription of Triadic Dialogue 8A – 9F are shown in *Figure 3.5-III* below.

Rising intonation	?
Continuing intonation	,
Stress	TEXT
Short untimed pause (~one-half second or less)	.. (truncated ellipsis)
Short untimed pause (~one-half second or more)	... (ellipsis)
Spoken slowly	<text>

Spoken quickly	>text<
Lengthened syllable	:
Word cutoff	-
Spoken softly	°text°
Spoken loudly	TEXT
Unclear speech	[unclear]

Figure 3.5-III The information and/ or conventions of transcription included in the transcription of Triadic Dialogue 8A – 4H

An example of a transcription for Triadic Dialogue 8A – 4H, included in Appendix C (pp.148 – 276), is shown in *Figure 3.5-IV* below.

K115	T	<u>now</u> we # STOPPED here..
K116		we # said
K117		that you # can ADD vectors acting in the same direction ^{repetition1}
K118		<u>so</u> we # have..SAME,..direction,..
K119		<u>and</u> we # said here
K120		this # is the same as what? as?
K121		ANGLE,..between,..vectors, ^{repetition2} # is what? equals zero..
K122		right?..
K123		zero degrees
K124		okay?
		[chalkboard (6)]

Figure 3.5-IV An example of a transcription for Triadic Dialogue 8A – 4H

The additional conventions of transcription for Triadic Dialogue 8A – 9F are explained further in 3.6.

Lastly, the presentation of Triadic Dialogue 8A – 4H in Chapter 4 is influenced by the mode of analysis adopted in this study, namely discourse analysis. As SFL yields a fine grained analysis it has been necessary to work very intimately with the text in the interpretation and analysis of the data in Chapter 4 in order to contextualize the detail that has been uncovered.

As a result, the transcripts for Triadic Dialogue 8A – 4H are included in Chapter 4. In addition, Triadic Dialogue 8A – 4H is divided into ‘stages’ (Martin and Rose, 2003) in order to ‘manage’ the text. These stages are marked by ‘internal addition’, as discussed in 2.3, where the teacher adds a new stage to what is being said or a ‘sidetrack’ to the flow of discourse (Martin and Rose, 2003). Lastly, a narrative style has been adopted in Chapter 4 to take the reader through the stages of each Triadic Dialogue before conclusions are drawn. It has thus been possible to examine the four central concepts of the developmental model at the micro level of classroom interaction.

As discussed in 3.3 “a dimension of great rigour into teacher’s pedagogic practices” is important if research is to go beyond the dichotomy of, for example, the ‘competence’/ ‘performance’ based model of teaching (Morais and Neves, 2001).

Researchers who also have worked intimately with the text in the interpretation and analysis of their data are, for example, Barnes (1969); Cazden (1988); Christie (2002); Edwards and Westgate (1994); Gee (1996); Lemke (1993); Martin and Rose (in press); Probyn (2004); and Wells (1999).

3.6 ANALYSIS OF THE DATA

The analysis of the data has been twofold.

Firstly, an analysis of the whole text has been done. The analysis involved the tabulation of utterances to do with the four central concepts of the developmental model, namely (1) power and control (i.e. stronger/ weaker classification and/ or framing); (2) moral regulation (e.g. explicit reference as to what it means to be a science learner); (3) social semiotic systems (e.g. scientific and non-scientific discourse and texts); and (4) a developmental history (i.e. progression), for each of the lessons videotaped and transcribed, i.e. Lessons A – I. Christie (2002) and Lemke (1998a) state that the analysis of the texts selected for more in-depth interpretation and analysis should be done in relation to the whole text.

Secondly, the principle mode of analysis – discourse analysis – has been used to analyse the four central concepts of the developmental model at the micro level of classroom interaction.

An example of the analysis for Triadic Dialogue 8A – 4H, included in Appendix C (pp.148 – 276), is shown in *Figure 3.6-I* below.

			REGULATIVE REGISTER	INSTRUCTIONAL REGISTER
K113	T	<u>NOW</u>..we # said	<u>INTERPERSONAL</u> <i>For example:</i> MODALIZATION - ‘we said that you can add vectors acting in the same direction’ [K116; K117] (finite: modal) (degree of modalization: low)	
K114		<u>okay NOW if</u> [unclear]		
K115		<u>now we # STOPPED here</u>..		
K116		we # said		
K117		that you # can ADD vectors acting in the same direction ^{repetition1}		
K118		<u>so we # have</u> ..SAME,..direction,..	<u>EXPERIENTIAL</u> <i>For example:</i> PROCESSES - ‘now we said ’ [K113]; ‘we said ’ [K116]; ‘and we said here ’ [K119] (Pr: verbal)	
K119		<u>and we # said here</u>		
K120		this # is the same as what? as?		
K121		ANGLE,..between,..vectors, ^{repetition2} # is what? equals zero..		

K122	right?..	<u>LOGICAL</u> <i>For example:</i> CONJUNCTION	<u>LOGICAL</u> <i>For example:</i> CONJUNCTION
K123	zero degrees	1) external conjunction:	1) external conjunction:
K124	okay? [chalkboard (6)]	- 'if' [K114] (conjunction type: 'consequence'; 'condition')	- 'so' [K118] (conjunction type: 'consequence'; 'cause')
K125	>the angle between the vectors ^{repetition2} # is now equal to zero degrees<	<u>TEXTUAL</u> <i>For example:</i> _CONJUNCTION 1) internal conjunction: - 'now' [K113] (conjunction type: 'addition'; 'staging'; 'framing')	<u>TEXTUAL</u> <i>For example:</i> REFERENCE 1) exophoric: - 'this is the same as what as' [K120]

Figure 3.6-I An example of the analysis for Triadic Dialogue 8A – 4H

The following decisions made in the analysis and interpretation of the data, in particular, are noteworthy.

Firstly, as evident from Figure 3.6-I, to do the analysis (in particular, a theme analysis as discussed in 2.3) the phase of discourse for each Triadic Dialogue has been divided roughly into clauses; that is:

- (1) Projected clauses (Halliday, 1994), such as 'we said that you can add vectors acting in the same direction' [K116-K117], have been separated.
- (2) In addition, clauses of expansion (Halliday, 1994), i.e. independent and dependent clauses, such as 'we have same direction and we said here this is the same as what as angle between vectors is what equals zero degrees' [K118-K121], have also been separated.
- (3) However, embedded clauses (Halliday, 1994), such as 'you can add vectors [[acting in the same direction]]' [K117], have not been separated.

Although the division of spoken discourse into ‘information units’¹⁴ (Halliday, 1994) as opposed to clauses might be considered more appropriate, the decision to divide the data into clauses has been taken for the following two reasons:

- (1) Firstly, identifying ‘information units’ is difficult. Brown and Yule state “it is frequently difficult or impossible to identify the single peak of prominence round which a tone group is structured” (1983:158) and “experienced judges, in a series of experiments, were not able to identify ‘tonics’ consistently” (1983:164).
- (2) And secondly, others who have used discourse analysis as the principle mode of analysis have transcribed spoken as written discourse and have therefore divided the discourse into sentences and clauses (Christie, 2002; Lemke, 1993; Martin and Rose, in press).

Secondly, as is evident from *Figure 3.6-I*, the following approach taken by Christie (2002) in the analysis and interpretation of the pedagogic discourse has been used:

- (1) Firstly, although it is acknowledged that there is only one discourse for the purposes of analysis, the pedagogic discourse has been separated into the regulative and instructional discourse.
- (2) Secondly, although it is acknowledged that the three metafunctions operate simultaneously in the creation of meaning in relation to context for the purposes of analysis, the three metafunctions have also been separated.
- (3) And thirdly, **bold** text has been used to suggest the operation of the regulative discourse and plain text to suggest the operation of the instructional discourse.

Thirdly, in terms of the additional conventions of transcription used conjunctions have been underlined; the symbol ‘#’ has been used to indicate the theme-rheme boundary as discussed in 2.3; and the transcriptions have been renumbered as shown in *Figure 3.6-II* below.

¹⁴ The information unit is defined as a feature of speech which refers to the pitch contour or tone produced in speaking (Christie, 2002). In addition, “While information units do not correspond completely to any unit in the clause grammar, it happens that the nearest grammatical unit is the clause” (Christie, 2002:17).

8A	<i>from</i>	Transcript A	<i>renumbered in</i>	Transcript J
1B	<i>from</i>	Transcript B	<i>renumbered in</i>	Transcript K
9F	<i>from</i>	Transcript F	<i>renumbered in</i>	Transcript L
4H	<i>from</i>	Transcript H	<i>renumbered in</i>	Transcript M

Figure 3.6-II The renumbering of the transcripts for Triadic Dialogue 8A – 4H

Lastly, the code-switches in Triadic Dialogue 8A – 4H have been translated from isiXhosa into English and included in Transcripts J – M in Appendix C (pp.148 – 276), as well as in the interpretation and analysis of the data in Chapter 4.

3.7 ADDRESSING VALIDITY THREATS

A number of steps have been taken to address validity threats in this study.

Firstly, repeated observations of lessons have been made spanning the first two terms of the school year. Repeated observations provide more data, more different kinds of data and data that are more direct and less dependent on inference; in addition, spurious observations and premature theories are less likely to be made (Becker and Geer, as cited in Maxwell, 2005:110).

Secondly, ‘rich’¹⁵ data has been obtained through (1) observing ~25 lessons; (2) taking detailed and descriptive notes during ~15 of the lessons; (3) videotaping 9 of the lessons and then transcribing the lessons; (4) taking notes after having observed lessons and/ or having spoken to the teachers or learners; and (5) collecting the teachers’ notes, handouts, the learners’ notebooks, and the textbook(s) used by the teachers and learners.

¹⁵ ‘Rich’ data is defined as “data that are detailed and varied enough that they provide a full and revealing picture of what is going on” (Becker, as cited in Maxwell, 2005:110).

Thirdly, feedback has been obtained from the teachers before, during and after the analysis of the data. This feedback has been recorded in the journal kept throughout this study; examples of journal entries are included in Appendix A (pp. 10 – 13). Following the completed analyses briefing sessions have also been held with the teachers. Reason and Rowan (as cited by Lather, 1986:67) state “good research at the non-alienating end of the spectrum...goes back to the subject with the tentative results, and refines them in the light of the subject’s reactions.” The findings of the research will also be made freely available to the schools, teachers, and learners concerned.

And lastly, feedback to check for biases and assumptions, as well as flaws in logic and methods, have been asked for from my supervisor, co-supervisors and critical friends. (Maxwell, 2004).

CONCLUSION

In Chapter 3 I explained the decisions associated with the different dimensions of doing research into classroom practice in this study.

In 3.1, the purpose of the preliminary study was discussed: to learn more about the ‘context of situation’, ‘context of culture’, and the nature of the spoken and written texts produced in the classroom.

In 3.2, the reason for situating the study within a sociocultural model was explained in light of current views of knowledge and the need for research into classroom practice in South Africa.

In 3.3, discourse analysis was explained to be an appropriate mode of analysis for the following reasons:

- (1) The need for research into classroom practice to be rigorous in order to move beyond the dichotomy of the ‘traditional’/ the ‘progressive’;

- (2) The need to understand in detail teaching and learning through the language of science and therefore the relation between practice and policy; and
- (3) The need to use a ‘canonical’ model of analysis that allows other researchers to enter into the discussion and compare their interpretations of data with the interpretations made in this study.

In 3.4, the selection of the data to do with the science classroom, the Activity Type ‘Triadic Dialogue’, and the four texts associated with the four central concepts of the developmental model was explained.

In terms of the science classroom, a grade 10 science classroom is the community of interest in this study. In addition, data from another grade 10 and grade 11 classroom has been generated as the basis of discourse analysis is comparison, and as the notion of progression is investigated in this study.

In terms of the notion of an Activity Type, the lessons are largely segmented into the different Activity Types identified by Lemke (1993) by recognizing the start of a new Activity Type by a change in topic.

In terms of the four texts analyzed in-depth, the characteristics of a competence and performance model, the ‘languages’ of science, and a ‘developmental history’, are evident in all the texts analyzed, however, they are most noticeable in the texts in which they are foregrounded during the analysis.

In 3.5, the presentation of the data to do with Transcripts A – I, Transcripts J – M, and the transcriptions presented in Chapter 4 was explained.

In terms of Transcripts A – I, the lessons are transcribed at the ‘lexical’ level. In addition, the written, mathematical and visual literacies, constructed on the chalkboard are included.

In terms of Transcripts J – M, the system of transcription proposed by Dressler and Kreuz (2000) is adopted for the purposes of this study. The conventions of transcription are summarized in *Figure 3.5-III*.

In terms of the transcriptions presented in Chapter 4, the presentation of the data is influenced by the mode of analysis adopted. As SFL yields a fine grained analysis the transcriptions are included in Chapter 4 in order to contextualize the detail that is uncovered. In addition, the four texts are divided into stages according to ‘internal addition’, as discussed in 2.3, in order to ‘manage’ the text.

In 3.6, the analysis of the data was discussed. The approach taken in the analysis of the pedagogic discourse might be summarized as follows: the pedagogic discourse is separated into the regulative and instructional discourse, the three metafunctions (as discussed in 2.3.1) are separated, and bold and plain text are used to suggest the operation of the regulative and instructional discourse, respectively.

Finally, in 3.7, issues to do with possible validity threats were put forward. Steps taken to address possible validity threats include: repeated observations, ‘rich’ data, feedback from the teachers concerned, and feedback from my supervisor and co-supervisors.

CHAPTER 4

DATA INTERPRETATION AND ANALYSIS

In Chapter 4 I report on the analysis of the four texts selected. The analysis of the four texts is included in Appendix C (pp.149 – 244). As explained in 3.6 the four texts are analyzed and interpreted in relation to the whole text, i.e. the 9 lessons videotaped and transcribed. In addition, as discussed in 3.4, the ~25 lessons observed, the journal kept throughout this study, and the analysis of various documents informs the analysis.

The chapter is subdivided into four sections, 4.1 – 4.4, according to the four texts selected, each of which foregrounds a central concept of the developmental model. The concept of the developmental model foregrounded in each of the four texts and the theories used in the analysis and interpretation of the data are summarized in *Figure 3.4-VI* in Chapter 3.

Each text is divided into ‘stages’ (Martin and Rose, 2003), as explained in 3.5, in order to ‘manage’ the text. These stages are marked by ‘internal addition’, as discussed in 2.3. In addition, as discussed in 3.6, each text is analyzed at the micro level of classroom interaction using SFL and a narrative style is adopted to contextualize the detail that is uncovered.

A brief summary of the findings then concludes the chapter.

4.1 POWER AND CONTROL FOR THE ACTIVITY TYPE TRIADIC DIALOGUE 8A

In Triadic Dialogue 8A¹⁶, *Stages I – VIII*, I report on the analysis for the notion of power and control that marks the pedagogic social context, namely the science classroom.

¹⁶ Transcript 8A, the eighth Activity Type for Lesson A, is included in Appendix B (pp.21 – 24).

As discussed in 2.1.1, Bernstein's (2000) notion of classification and framing is used for the translation of power and control, respectively.

In reporting on the analysis for *Stages I – VIII* the following is foregrounded:

- 1) The strengthening and weakening of classification and framing;
- 2) The possible reasons for the strengthening and weakening of classification and framing;
- 3) And the possible implications of strengthening and weakening classification and framing.

A brief summary of the findings is then provided to conclude the section.

4.1.1 *STAGE I*

J1	T	let's # now, brainstorm again here
----	---	---

At the macro level, Triadic Dialogue 8A is marked by strong classification and framing. It is evident from *Stage I* (also *Stage VI* and *Stage VIII*) that it is the teacher, Mr. Maleto, who controls the content, namely 'a force makes things to move', for Triadic Dialogue 8A.

In *Stage I* Triadic Dialogue 8A is strongly framed. Mr. Maleto establishes a clear boundary between the previous topic 'velocity and displacement' and the new topic 'force' by using the formulaic starter 'let's now brainstorm again here' [J1]. Formal lessons with clear boundaries are recognized to be an important structural characteristic of lessons that work for language learning (Wong-Fillmore, 1985). In J1 Mr. Maleto's learners are therefore prepared to participate in Triadic Dialogue 8A.

In *Stage I*, however, the framing at the level of hierarchical rules (i.e. in maintaining personal control in fostering an open relationship with the learners) is weaker. Mr. Maletto uses the first person plural ‘us’ [J1] to identify with the learners as a group and hence starts to build a positive socio-affective disposition towards participating in Triadic Dialogue 8A (Christie, 2002 and Morais and Neves, 2001).

J2	T	when YOU # move...
J3		when..SOMETHING # moves
J4		or when YOU # move...
J5		OR we # say
J6		when SOMETHING # is in MOTION

The strong classification and framing at the macro level for *Stage I* means that science is taught as having a distinctive technical language. Much of this technical language is expressed through the resource of grammatical metaphor. In *Stage I* Mr. Maletto introduces the nominalization ‘motion’ into Triadic Dialogue 8A by stating ‘**or we say** when something is in motion’ [J5-J6]. Experientially, Mr. Maletto contrasts ‘moves’ and ‘is in motion’ by placing them in ‘Parallel Environments’ (Lemke, 1993) when he states ‘when something moves’ [J3] and ‘when something is in motion’ [J6]. The learners are thus able to make sense of the metaphorical form of expression ‘is in motion’ against the background of the congruent form of expression ‘moves’.

J7	T	>what # makes things to move?<...	
J8		>what # makes things to move?<...	
J9		>what # makes things to move?<...	[J10-J12 omitted]
J13		if you # begin to move	
J14		something # must be happening	
J15		what what # makes things to move?..	
J16		yes?	

In *Stage I* there is also weaker framing of pacing. In the move Teacher Initiation Mr. Maletto restates the question ‘what makes things to move?’ [J7; J8; J9 and J15] four times before receiving a response. Research has shown that language learning takes place when

teachers who have reason to communicate with their learners adjust their speech by making greater use of repetitions and rephrasings than usual (Wong-Fillmore, 1985). Furthermore, Lemke (1993) states that weaker framing of pacing favours the learners' interests (namely, to have the least amount of material taught for which they will be held responsible on a test) not the teachers' interests (namely, to complete the curriculum). It is evident from *Stage I* that Mr. Maletto needs to weaken the framing of pacing to accommodate his learners in the bilingual physical science classroom.

J17	L	force
J18	T	a FORCE
J19		ne?
J20		a FORCE # makes things to move,

Finally, in *Stage I*, even though Mr. Maletto controls the content at the macro level of classification and framing, a learner shows willingness to adopt the lexis of the field and therefore to situate him-/ herself as a member of this particular discourse community (Gee, 1996 and Schleppegrell, 2001). In the move Learner Response a learner introduces the key lexical item 'force' into Triadic Dialogue 8A.

4.1.2 STAGE II

J21	T	okay, okay, okay, okay, okay,
J22		a FORCE # makes things to move...
J23		I # 'm going to FORCE this wall to move
J24		I # 'm going to FORCE this thing to move...

In *Stage II* the classification and framing between academic and non-academic knowledges is weakened.

Mr. Maletto weakens the classification and framing between academic and non-academic knowledges when he uses an example from 'the everyday' to rebut the statement 'a force

makes things to move' [J22]. In *Stage II* Mr. Maletto states 'I'm going to force this wall to move' [J23] and pushes against the classroom wall.

J25	T	°but you # said
J26		a FORCE # can make things to move°...
J27		but you # had it WRONG..
J28		°there # is something you # don't understand°..
		°you # don't understand about WHAT? about°?
J29		yes?
J30	L	force of gravity
J31	T	°FORCE of GRAVITY°

As the demonstration counters the learners' expectation that 'a force makes things to move' Mr. Maletto uses the resource of concession in '**but you said** a force can make things to move' [J25-J26]. In addition, to refer to what was just said by the learner and to evaluate it as '**wrong**' [J27] Mr. Maletto uses the resource of text reference in '**but you said** a force can make things to move' [J25-J26]. Eduran, Simon and Osborne (2004:921) claim that a rebuttal is a significant indicator of the quality of argumentation discourse since it causes both participants to evaluate the validity and strength of an argument.

Mr. Maletto thus models 'argumentation' discourse in *Stage II* by rebutting the statement 'a force makes things to move'. The framing at the level of participation (i.e. who gets to talk) is stronger when Mr. Maletto models 'argumentation' discourse and scientific discourse in Triadic Dialogue 8A.

4.1.3 STAGE III

J32	T	okay, okay, so you # mean
J33		things # move because of force of gravity?...

In *Stage III* Mr. Maletto strengthens the classification and framing. Mr. Maletto interrupts Triadic Dialogue 8A to induct the learners into the language of science in response to the

learner's answer 'force of gravity' [J30]. As a result science is taught as having a distinctive technical language to be imparted in the pedagogic activity.

J34	T	now..I # would like you to..as from today..	
J35		okay don't speak # of the force OF something	
J36		okay don't speak # of the force OF something	
J37		because?	
J38		THINGS # don't have what?...	
J39	L	force	
J40	T	force...	
J41		but as but things # always EXERT..a force...	[J42-J43] omitted

When Mr. Maleto strengthens the classification and framing in *Stage III* Mr. Maleto's authority, as teacher, comes through in Triadic Dialogue 8A. Furthermore, Mr. Maleto draws upon a number of resources to establish what constitutes appropriate language use in the context of the science classroom.

Firstly, Mr. Maleto uses the first person singular 'I' in '**I would like you to**' [J34] [also J67 and J68] when he demands the following 'goods and services' – the learners are not to use the phrase 'force of gravity'. This is initially expressed by the non-typical clause Mood declarative '**I would like you to**' [J34] which employs the finite verbal operator '**would**' to express a median degree of obligation or necessity on behalf of the learners to not use the phrase 'force of gravity'. However, the non-typical clause Mood declarative '**I would like you to**' is cut short and becomes the typical clause Mood imperative '**don't speak** of the force of something' [J35]. Experientially, Mr. Maleto uses the behavioural processes '**don't speak**' [J35; J36; J64] and later on '**listen**' in '**listen to that very carefully**' [J48] to regulate the learners' behaviour. In addition, Mr. Maleto creates a clear demarcation between how the learners used to talk about force and gravity and how they ought now to talk about force and gravity with his reference to time in '**I would like you to as from today**' [J34].

J44	T	I # can, put ON force on this table..	
J45		it # doesn't mean	

J46		that I # have force	[J47 omitted]
J48		listen # to that very carefully..	
J49	T	I # don't possess force..	
J50		I # DON'T possess force	
J51		[unclear] >I # don't have force<	
J52		but I # KNOW	
J53		a force # is ACTING on me...	
J54		and..I # can also..EXERT..a force	[J55-J62 omitted]
J63		>but I # don't have force<	
J64		so don't speak # of..the force of gra:vity	

Secondly, Mr. Maletto uses the resource of concession in *Stage III* to counter learner J31's expectation that 'I possess a force if I exert a force or a force acts on me'. Mr. Maletto states 'I can make a force to act on something but I don't have force' [J62-J63] [also J41 and J52]. In addition, Mr. Maletto uses the resource of negation to take on the voices of the learners and the 'older folks' and denies them. Mr. Maletto states 'I don't possess force' [J49], 'I don't possess force' [J50] and 'I don't have force' [J51] [also J38]. The authority of the text also comes through in *Stage III* when Mr. Maletto uses the resource of monoglossia to speak with 'one clear voice' (Martin and Rose, 2003). Mr. Maletto states 'it doesn't mean that I have force' [J45].

J65	T	I know #
J66		older people like ourselves and older folks #
		speak of what force of gravity...
J67		okay but I # don't like it

Thirdly, Mr. Maletto's authority, as teacher, comes through in Triadic Dialogue 8A as he shapes the identity of the learner, as a science learner, in the pedagogic activity of *Stage III*. In *Stage III* Mr. Maletto introduces multiple voices into the text via projection. He states '**older people like ourselves and older folks speak** of [say] what force of gravity' [J66]. In doing so Mr. Maletto attributes the source of the projection 'force of gravity' to '**older people**' or '**older folks**' [J66]. Mr. Maletto thus makes a distinction between how

grade 10 physical science learners talk and how less well educated ‘older folk’ from the non-scientific community outside the school talk.

J68	T	I # ’m happier you know to say... GRAVI:TA:TIONAL force OR..the force EXERTED by?
J69	L	gravity
J70	T	gravity
J71		okay >that # becomes more scientific<
J72		>that # becomes more more scientific<
J73		the force exerted by gravity or GRAVI:TA:TIONAL force

Lastly, Mr. Maleto, as teacher and authority in the science classroom, uses the resource of ‘Appraisal’ (Martin and Rose, 2003) to express his positive appreciation for the phrase ‘gravitational force’ or ‘the force exerted by gravity’ by stating ‘**okay that becomes more scientific**’ [J71].

In *Stage III*, however, it is evident that what constitutes appropriate language use in the context of Mr. Maleto’s science classroom is to some degree idiosyncratic to him and his learners.

For example, ‘of’ has a general meaning ‘belonging to’ as well as a more specific meaning ‘used to show that something belongs to a category’ (Oxford English Dictionary). Mr. Maleto interprets ‘of’ in the phrase ‘force of gravity’ (*Figure 4.1.3-I*) to be the more general meaning ‘belonging to’. He states ‘things don’t have what force’ [J38-J39].

force	of gravity
Thing	Qualifier

Figure 4.1.3-I The nominal group ‘force of gravity’

Mr. Maletto therefore expects his learners to use the phrase ‘gravitational force’ (*Figure 4.1.3-II*) or ‘the force exerted by gravity’ (*Figure 4.1.3-III*) instead of the phrase ‘force of gravity’.

gravitational	force
Classifier	Thing

Figure 4.1.3-II The nominal group ‘gravitational force’

the	force	[[exerted	by	gravity]]
Deictic	Thing			

Figure 4.1.3-III The embedded clause ‘exerted by gravity’ as Qualifier

In contrast, in Lesson G¹⁷, Mrs. McKenzie states ‘don’t ever just say gravity either say force of gravity [emphasis mine] or acceleration due to gravity’ [2.38G-2.39G].

Mr. Maletto’s learners therefore gain ‘sociolinguistic competence’ (Schleppegrell, 2001:436) when Mr. Maletto strengthens the classification and framing in *Stage III*. In other words, Mr. Maletto’s learners learn how to make the linguistic choices that realize appropriate texts in the science classroom, i.e. where the phrase ‘force exerted by gravity’ and ‘gravitational force’ are appropriate and the phrase ‘force of gravity’ inappropriate in Mr. Maletto’s class.

However, it is evident from *Stage III* that the texts learners are inducted into may be idiosyncratic to a teacher and his/ her learners.

¹⁷ Transcripts A – I, for Lessons A – I, respectively are included in Appendix B (pp.14 – 147). Transcript G, for Lesson G, is included in Appendix B (pp.106 – 114).

4.1.4 STAGE IV

J74 **T** okay now..okay what # can FORCE do?
J75 **give # me** things that force can do..

In *Stage IV* ('a brainstorming session') the classification and framing is weaker. Mr. Maletto states '**okay now okay** what can force do? **give me** things that force can do' [J75-J75].

In terms of classification there is a weaker degree of boundary maintenance between contents. The learners' responses (for example, 'it [force] can change the shape of an object' [J124]) exceed the boundaries of Mr. Maletto's lesson (namely, 'a force makes things to move'). In terms of framing there is a greater range of options available to the learners in the control of what is received [J77; J90; J104; J115 and J124] in the context of 'the pedagogical relationship' (Bernstein, 2000).

In 'the brainstorming session' there is a gathering of ideas. Mr. Maletto starts where the learners are at and values their voices. Mr. Maletto writes the learners' responses to the question 'what can force do?' [J74] on the chalkboard. Writing the learners' responses on the chalkboard allows Mr. Maletto and the learners to arrest the flow of speech and to compare the utterances that have been made at different times side-by-side (*Figure 4.1.4-I*) (Goody and Ian Watt as cited by Gee, 1996:50).

<p><u>Force</u> - can change direction - force can move an object from one place to another - can stop moving objects - can change the shape of an object</p>

Figure 4.1.4-I Chalkboard (7)

J76	T	yes?
J77	L	it # can CHANGE the direction
J78	T	it # can change
J79		okay force
J80		let's have a look at that..
J81		force # ...
J82		[code-switches] [we have not written anything yet ne]
J83		force # ...can change? what?
J84	L	direction
J85	T	direction
J86		[code-switches] ¹⁸ [anybody else]
J87		yes I # agree
J88		anybody else?
J89		yes?

Although the classification and framing for *Stage IV* ('a brainstorming session') is weaker, it is also evident from *Stage IV* that at times Mr. Maletto's utterances suggest weaker framing [J80; J94; J95] and at other times Mr. Maletto's utterances suggest stronger framing [J87].

In the move Teacher Follow-up¹⁹ the framing is initially weaker when Mr. Maletto states '**let's have a look at** that' [J80]. Mr. Maletto uses the first person plural '**us**' [J80] to identify with the learners as a group (Christie, 2002). In addition, Mr. Maletto uses the resource of text reference 'that' [J80] as well as experientially the process of cognition '**have a look at**' [J80] to invite the learners to evaluate the statement 'force can change direction' [chalkboard (7); *Figure 4.1.4-I*]. Furthermore, in the move Teacher Initiation the framing is weaker. Mr. Maletto invites learners to participate in 'the brainstorming session' by stating '**anybody else?**' [J88] [also '**another one**' in J102; J113 and J122]. However, in the move Teacher Follow-up the framing is stronger when Mr. Maletto states

¹⁸ The moves for Triadic Dialogue, namely: Teacher Preparation, Teacher Question, Teacher Call for Bids, Learner Bid to Answer, Teacher Nomination, Learner Response, Teacher Evaluation, and Teacher Elaboration, are explained in 2.2.

¹⁹ The translation for the code-switches is included in square brackets. For example, in J86 the teacher states: "Anybody else."

‘**yes I agree**’ [J87] where Mr. Maletto’s authority is evident in his use of the first person singular ‘I’ [J87].

The reason for these disparities might in part be understood on examination of the utterances J94 and J96. Although the teacher states ‘**do you agree?**’ in J94 and again ‘**do you agree?**’ in J95 there is no Learner Response. Research has shown that learners interact with their teachers quite selectively and therefore determine to a large extent what actually happens in the classroom (Jones, 1989:23). It is thus evident that both the teacher and learners are actively constructing ‘what goes on’ in Triadic Dialogue 8A and whether or not *Stage IV* is weakly or strongly framed (Jones, 1989).

J90	L	it # can TAKE an object from one place to another place
J91	T	it # can MO:VE an object
J92		okay it # can, can, can, can DISPLACE an object

Furthermore, although the framing for *Stage IV* (‘a brainstorming session’) is weaker, in *Stage IV* [J90-J105] Mr. Maletto strengthens the classification and framing in the move Teacher Follow-up when he restates the learners’ responses in a language that conforms more to the language of science.

For example, a learner responds to the question ‘what can a force do?’ [J74] by stating ‘it [force] can take an object from one place to another place’ [J90] (*Figure 4.1.4-II*). In response to the question the learner uses the abstraction ‘force’ where the ‘virtual entity’ ‘force’ stands in contrast to the person ‘I’ in ‘I’m going to force this wall to move’ [J23] stated earlier on by the teacher (*Figure 4.1.4-III*).

it	can	take	an	object
Agent	Pr: material		Medium	

from	one	place	to	another	place
Circ: location			Circ: location		

Figure 4.1.4-II Analysis of Transitivity for J90

I	'm	going	to	force	this	wall	to	move
Agent	Pr: causative			Medium			Pr: material	

Figure 4.1.4-III Analysis of Transitivity for J23

Initially Mr. Maletto replaces the material process ‘can take’ with the material process ‘can move’ in ‘it can move an object’ [J91] and then the material process ‘can displace’ in ‘it can displace an object’ [J92] (Figure 4.1.4-IV). By stating ‘it can move an object’ [J91] and then ‘it can displace an object’ [J92] Mr. Maletto also contrasts ‘move’ with ‘displace’ by placing them in ‘Parallel Environments’ (Lemke, 1993).

it	can	displace	an	object
Agent	Pr: material		Medium	

Figure 4.1.4-IV Analysis of Transitivity for J92

J93	T	it # can MAKE an object move from ONE place to? ANOTHER place
J94		do you # agree?
J95	Ls	(yes)
J96	T	do you # agree?
J97		yes, yes, force # you know can do that okay..

Then Mr. Maletto restates the learner’s response to include the causative process ‘can make’ in ‘it can make an object move from one place to another place’ [J93] (Figure 4.1.4-V).

it	can	make	an	object
Agent	Pr: causative		Medium	

move	from	one	place	to	another	place
Pr:material	Circ: location			Circ: location		

Figure 4.1.4-V Analysis of Transitivity for J93

J98	T	now okay force # ...can...can uh move an object..from..eh..from one place okay to another
J99		it # means
J100		it # can..it can cause things to..to change positions...

Finally Mr. Maletto states the process as causative and replaces the circumstantials of location ‘from one place to another place’ with the range ‘position’ in ‘it [force] can cause things to change positions’ [J100] (*Figure 4.1.4-VI*).

it	can	cause	things	to	change	positions
Agent	Pr: causative		Medium	Pr: material		Range

Figure 4.1.4-VI Analysis of Transitivity for J100

J101	T	okay?..
J102		another one?...
J103		[name]
J104	L	it # can make a STANDING object START moving
J105	T	it # can CAUSE motion..
J106		yes, yes,
J107		[code-switches] [what else]

Another example is provided when a learner responds to the question ‘What can a force do?’ [J74] by stating ‘it can make a standing object start moving’ [J104]. The learner now includes the causative process ‘can make’ (*Figure 4.1.4-VII*). It is thus evident that this learner has begun to appropriate the language of science.

it	can	make	a	standing	object	start	moving
Agent	Pr: causative		Medium			Pr: material	

Figure 4.1.4-VII Analysis of Transitivity for J104

In the move Teacher Follow-up Mr. Maleto restates the learner’s response as ‘it can cause motion’ [J105]. Mr. Maleto uses the nominalization ‘motion’ which is a more ‘metaphorical’ form of expression as opposed to the more ‘congruent’ one ‘to move’ (Figure 4.1.4-VIII).

it	can	cause	motion
Token	Pr: circumstantial		Value

Figure 4.1.4-VIII Analysis of Transitivity for J105

J108	T	it # can make things	
J109		it # can move	
J110		because you know I # was HERE	
J111		I # can now move from HERE to HERE	
J112		so I # started to move	
J113		yes, another one?	
J114		yes?	
J115	L	it # can STOP moving things	
J116	T	>it # can STOP moving things<	
J117		okay I # agree..	[J118-J121 omitted]
J122	T	yes, another one?	
J123		yes?	
J124	L	it # can CHANGE the SHAPE of an object	
J125	T	it # can CHANGE the SHAPE of an object	
J126		very good..very good..	[J127-J128 omitted]

Finally, in *Stage IV*, it is also evident that the language the learners are being inducted into conforms more to the language of science than the language of ‘the everyday’. Veel (1997) states that a shift towards increased ‘consequential conjunctions’ (Martin and Rose, 2003) indicates a movement in the text towards more abstract discourse.

In J110 and J112 Mr. Maleto uses the ‘consequential conjunctions’ ‘because’ and ‘so’ to express the causal relation between ‘force’ and ‘motion’. Furthermore, in Triadic Dialogue 8A Mr. Maleto uses the following consequential conjunctions:

- consequential conjunctions of cause ‘because’ [also J184] and ‘so’ [also J161; J162 and J182]
- and the consequential conjunction of condition ‘if’ [also J13; J129; J150; J164; J168; J173 and J181]

Mr. Maletto uses these conjunctions in his ‘causal explanation’ (Veel, 1997:179) of the relationship between ‘force’ and motion’ as well as ‘force’ and ‘a change in shape’.

4.1.5 STAGE V

J129	T	<u>or..if</u> you # do what?	[J130-J132 omitted]
J133		here # is RUBBER	
J134		I # can FORCE	
J135		I # can CHANGE the SHAPE	[J136 omitted]
J137		oh no I # even broke it there	[J138 omitted]
J139		that # ’s what’s force	

In *Stage V* the classification and framing between academic and non-academic knowledges is once again weakened.

Mr. Maletto interrupts Triadic Dialogue 8A to perform a demonstration in response to the learner’s answer ‘it can change the shape of an object’ [J125]. For the demonstration Mr. Maletto uses an example from ‘the everyday’, i.e. an eraser. However, contrary to Mr. Maletto’s and learners’ expectations the eraser breaks. Thus Mr. Maletto uses the continuative ‘even’ (expressing the logical relation of comparison between the unbroken versus the broken eraser) and light-heartedly remarks ‘oh no I even broke it there’ [J137]. Finally, Mr. Maletto uses the intensive process ‘is’ when he states ‘that’s what’s force’ [J139].

Mr. Maletto’s use of examples from ‘the everyday’ in *Stage II* [J23] and *Stage V* [J133], as well as in Lessons A – E [16.43A; 14.1D; 13.8H; 13.8H; 15.5H and 16.6H], are in line with the constructivist principles that underlie Curriculum 2005.

Research has shown, however, that texts that incorporate numerous examples intended to model everyday situations succeed only in further excluding learners from esoteric discourse (Dowling as cited by Muller and Taylor, 2000:67 and Martin and Halliday, 1993).

When the teacher introduces examples of everyday situations the teacher can simultaneously provide access to both ‘the everyday’ and ‘the scientific’ and thereby implicitly introduce the principles that permit distinction between the two contexts. However, these examples need to be explained on the basis of school knowledge. (Morais and Neves, 2001).

For example, Mrs. McKenzie also uses an example from ‘the everyday’, i.e. a stapler, to teach ‘a force does not necessarily make things to move’. However, in contrast to Mr. Maletto, she expects the learners to use school knowledge (‘the scientific’) to explain the example (‘the everyday’). In Lesson G Mrs. McKenzie states ‘I want a force diagram for this stapler which I am pushing towards the south...it’s not moving look at it’ [1.1G-1.3G]. The learners then drew the following force diagram for the stapler:

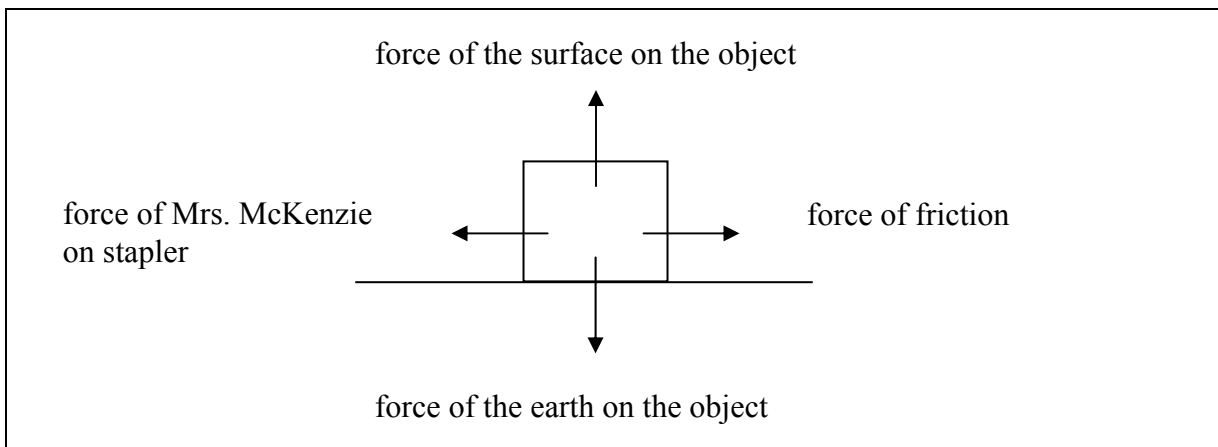


Figure 4.1.5-I Force diagram for the forces acting on the stapler [1.1G-1.3G]

The teacher and learners thus need to recognize that there is a sharp disjuncture between ‘the everyday’ and ‘the scientific’ (Walkerdine as cited by Muller and Taylor, 2000:68).

However, in Lessons A – E (and Lessons H – I in the case of the grade 11s) this disjuncture was not recognized by Mr. Maletto in the unit ‘mechanics’ as evident from the following three excerpts:

- (i) in nature and in our homes where do you normally get forces acting like this...there are so there are so many but you don’t observe these things [emphasis mine] [13.1H-13.5H]
- (ii) you get into [code-switches] [taxis] everyday you get into your fathers’ cars everyday or your moms’ cars everyday...you don’t look at these things [emphasis mine]...you don’t think of these things and you come and say science is tough it is not tough...but it is how you look at it that makes things to be tough [emphasis mine] [19.1A-19.6A]
- (iii) there is a boat almost what south east of what of Port Elizabeth it’s crew members all drowned [code-switches] there it’s all science in your news...so direction is important [12.49E-12.54E]

As a result of this disjuncture the learners’ understanding of force does not progress from ‘the everyday’ to ‘the scientific’ as the teacher and the learners engage in the Activity Type Triadic Dialogue in *Stage II* and *Stage V*. That Mr. Maletto’s learners tended to remain within ‘the everyday’ in terms of their understanding of force is in part evident from the learners’ responses in *Stage IV* (‘the brainstorming session’) [J77; J90; J104; J115 and J124]. Furthermore, because Mr. Maletto does not recognize this disjuncture the belief that “science is opposed to common sense” is fostered as the thematic discrepancy that exists between the teacher and learners is used to undermine common sense (Lemke, 1993). Lemke (1993:146-147) states:

what the eye “sees” has little enough to do with science learning...[instead] they [the learners] must learn to see as the teacher sees, to look for what he looks for, to see as relevant what he does, and to make sense of what they see according to a particular thematic pattern

In making formal discourse accessible to a wider range of learners Muller and Taylor recommend the following dual strategy: “‘one that knows the border and crosses the line’ (Anzaldua as quoted by Muller and Taylor, 2000:71), not one that crosses the line by acting as though the border were not there.” Furthermore, Muller and Taylor state “To repeat: to cross the line without knowing it is to be at the mercy of the power inscribed in the line.” (Muller and Taylor, 2000:71).

4.1.6 STAGE VI

J140	T	<u>now..my MAIN interest now on</u> force here # is THIS one...
J141		it can make things to move from one place to another place
J142	T	now remember #
J143		it # can make things to move from one place to another place..

In *Stage VI* Mr. Maleto returns to the ‘theme’ (Martin and Rose, 2003) ‘a force makes things to move’

Mr. Maleto uses a number of resources to strengthen the classification and framing. Firstly, Mr. Maleto uses the resource of text reference, i.e. the demonstrative ‘**this**’ [J140], to refer to the statement ‘force can move an object from one place to another’ written on the chalkboard. Secondly, Mr. Maleto uses the resource of ‘Appraisal’ (‘**interest**’ [J140]) to express his attitude towards the statement. Mr. Maleto states ‘**now my main interest now on force here is this one**’ [J140].

J144	T	and you # said..	[J145 omitted]
J146		it # can it can make things..to >START<..moving	[J147 omitted]

Lastly, Mr. Maleto uses the resource of projection to refer to what a previous learner said. He states ‘**and you said...it can make things to start moving**’ [J144-J146].

It is thus evident from *Stage VI* that it is the teacher, Mr. Maletto, who controls the content, namely ‘a force makes things to move’, for Triadic Dialogue 8A.

4.1.7 *STAGE VII*²⁰

In *Stage VII* Mr. Maletto strengthens the classification and framing when he interrupts Triadic Dialogue 8A to explicitly teach the key lexical items ‘stationary’ [12.1A] and ‘at rest’ [12.16A].

4.1.8 *STAGE VIII*

J148	T	now..she # said..
J149		force # can make things to move from REST..

In *Stage VIII* Mr. Maletto once again returns to the ‘theme’ ‘a force makes things to move’ by using the resource of text reference.

Mr. Maletto uses projection to refer to what a previous learner said and attributes the source of that projection to a particular learner through the resource of the third person singular ‘she’ [J148]. He states ‘**now she said** force can make things to move from rest’ [J148-J149]. Mr. Maletto is thus able to refer to a point that has been previously made earlier on in Triadic Dialogue 8A and to make some more meaning with it. (Martin and Rose, 2003).

It is thus evident that, as in *Stage I* and *Stage VI*, Mr. Maletto controls the content, namely ‘a force makes things to move’, for Triadic Dialogue 8A.

²⁰ *Stage VII* is an Interruption (Lemke, 1993) in which Mr. Maletto addresses language explicitly. As explained in Section 3.5 stages, such as *Stage VII*, have not been analyzed in depth when the length of the Triadic Dialogue is in excess of ~200 clauses so that the analysis of the text by SFL is manageable.

J150	T	now if something # moves from REST...
J151		okay... what # is the SPEED of something that is at REST?...
J152		mm ja ja...
J153		yes?
J154		uh?
J155	L	it # is stationary
J156	T	are you # sure?

Furthermore, as in *Stage I*, it is also evident that Mr. Maletto weakens the framing of pacing as well as the framing at the level of hierarchical rules in *Stage VIII*.

For example, Mr. Maletto weakens the framing at the level of hierarchical rules when he invites a learner to reconsider his/ her response to the question ‘what is the speed of something that is at rest?’ as a form of error correction. He states ‘**are you sure?**’ [J156]. As a result, Mr. Maletto is able to build a positive socio-affective disposition towards participating in Triadic Dialogue 8A. (Morais and Neves, 2001).

J157	L	zero
J158	T	it # is zero
J159		good
J160		anybody else?...

Furthermore, Mr. Maletto weakens the framing at the level of hierarchical rules when he invites the learners to answer the question ‘what is the speed of something that is at rest?’ by stating ‘**anybody else**’ [J160]. However, as a learner has already answered the question correctly, by stating ‘it is zero’ [J158], Mr. Maletto’s invitation to the learners to once more answer the question could be considered inappropriate. Mr. Maletto’s invitation to the learners to answer the question a second time might suggest that he is consciously trying to weaken the framing in *Stage VIII*.

J161 **T** >so the SPEED of something at rest # is always
what? is ZERO<
J162 so..**okay**..so...STATIONARY...SPEED...equal
to zero...
J163 SPEED [is] # equal to ZERO..
J164 **now** if the SPEED is # equal to ZERO..
J165 what # is the force ACTING on the object?
J166 uh?
J167 **L** [unclear]
J168 **T** if if the object # does not have any SPEED..
J169 what FORCE # is acting on the object?..
J170 hey?
J171 **L** it # 's standing sir
J172 **T** °**okay..listen # carefully**°..
J173 if the SPEED of the object is # ..ZERO
J174 what FORCE # is acting on the object?..
J175 **anybody?**
J176 **yes?**
J177 **L** no force
J178 **T** >no force # is actually is actually acting there<..
J179 no force # ..
J180 **good..**

Finally, from *Stage VIII* it is evident Mr. Maleto weakens the framing of spacing when he restates the question ‘if the speed of the object is equal to zero what is the force acting on the object?’ [J164-J165] three times before receiving a response evaluated to be correct. In addition, Mr. Maleto uses word stress, in conjunction with the behavioural process ‘listen’ in ‘**okay listen carefully**’ [J172], to focus the learners’ attention on the key lexical items ‘speed’ [J173], ‘zero’ [J173] and ‘force’ [J174] for the question J164-J165. As in *Stage I*, it is evident that Mr. Maleto makes these adjustments to his speech to accommodate his bilingual learners.

J181 **T** if..speed is # zero
J182 **so..we # say**
J183 the force here # ..equals..zero
J184 because [there # is] no speed

Mr. Maletto and the learners therefore build the following ‘taxonomic relation of Synonymy’ (Lemke, 1993:222) and ‘logical relation of connection’ (Lemke, 1993:222) in *Stage VIII*:

STATIONARY — Synonym/ synonym — REST POSITION — Synonym/ synonym —
SPEED = 0

Figure 4.1.8-I The taxonomic relation of synonymy built in *Stage VIII*

F = 0 — Cause/ Consequence — SPEED = 0

Figure 4.1.8-II The logical relation of connection built in *Stage VIII*

These semantic relations are represented on the chalkboard in *Stage VIII* by Mr. Maletto as shown in *Figure 4.1.8-III* below.

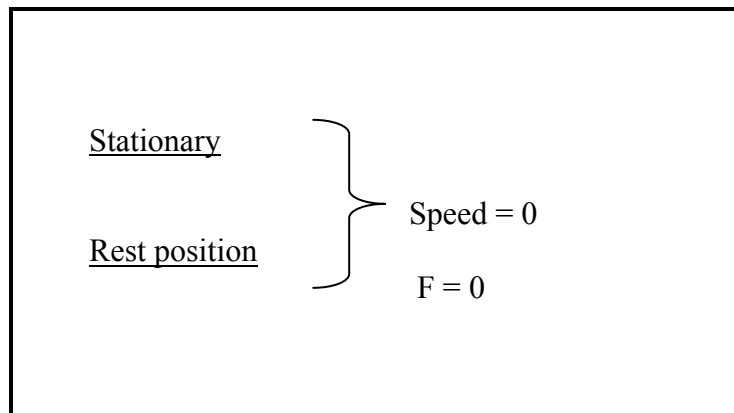


Figure 4.1.8-III Chalkboard (10)

Mr. Maleto clearly controls the content at the macro level of Triadic Dialogue 8A. However, it is evident that when Mr. Maleto weakens the classification and framing for Triadic Dialogue 8A, content that might otherwise be included is omitted. In *Stage I* and *VI* Mr. Maleto teaches ‘a force makes things to move’ [J20; J141; J146] and later on in *Stage VIII* Mr. Maleto teaches that ‘if the force is equal to zero then the speed is equal to zero’ [J181-J183]. However, Mr. Maleto does not make a distinction between ‘a force’ and ‘the resultant force’ and that it is ‘if the resultant force equals to zero that the speed is equal to zero’. As a result Mr. Maleto’s learners would not be able to give the reason why ‘a force does not necessarily make things to move’ [J21-J27] as demonstrated in *Stage II* from Triadic Dialogue 8A.

Another example of when Mr. Maleto chose to omit content is provided in Lesson D. Mr. Maleto states:

but don’t worry too much about this one so far just get to know that one it depends whether you chose this one as positive direction or this one as the negative direction but so far I’m choosing it for you that this side is positive this side is what is negative [emphasis mine] [11.6D-11.9D]

As a result the learners would not understand ‘the reasoning’ behind assigning a positive or negative value to direction, when solving for the resultant of vectors acting in the same straight line, from Lesson D.

Mr. Maleto needs to make decisions in real time as to whether or not to weaken or strengthen the classification and framing in *Stages I – VIII* for Triadic Dialogue 8A. It is evident from Triadic Dialogue 8A that Mr. Maleto weakens the classification and framing when he weakens the framing at the level of hierarchical rules; weakens the framing of pacing; weakens the classification and framing between academic and non-academic knowledges; and weakens the classification and framing when he and the learners engage in ‘the brainstorming session’.

These decisions might in part be influenced by Mr. Maletto's personality, Mr. Maletto's learners as well as the current climate of education in which Mr. Maletto and his learners operate in which Curriculum 2005 is being implemented for the first time in grade 10. In Lesson G, Mrs. McKenzie states 'remember you've got a change in syllabus and you're doing a simplified version of what used to be done in Matric here' [4.8G-4.9G]

However, it is evident from Triadic Dialogue 8A that these decisions have implications and therefore need to be made carefully by teachers.

CONCLUSION

In this section classification and framing for the Activity Type Triadic Dialogue, in the context of a science classroom, has been analyzed and discussed.

Triadic Dialogue 8A is defined by either strong or weak classification and framing which might be summarized as follows:

- 1) From *Stage I* (also *Stage VI* and *Stage VIII*) it is evident that it is the teacher, Mr. Maletto, who controls the content for Triadic Dialogue 8A. Therefore, at the macro level of Triadic Dialogue 8A, Triadic Dialogue 8A is marked by strong classification and framing.
- 2) In *Stage II* and *Stage V* Mr. Maletto weakens the classification between academic and non-academic knowledges by using examples from 'the everyday', namely 'the classroom wall' and 'the eraser', and without explaining these examples on the basis of school knowledge.
- 3) In *Stage III* and *Stage VII* Mr. Maletto strengthens the classification and framing when his authority as teacher comes through in Triadic Dialogue 8A as he gives scientific discourse a privileged status in his classroom and inducts his learners into this language.
- 4) In *Stage IV* Mr. Maletto weakens the classification and framing when he and the learners engage in 'a brainstorming session' where the learners' responses exceed

the boundaries of his lesson and where there is a greater range of options available to the learners in terms of what is received in the context of the pedagogical relationship.

These ‘waves’ (Martin and Rose, in press) of classification and framing for Triadic Dialogue 8A might be represented as shown in *Figure 4.1* below.

	FRAMING	CLASSIFICATION
Stage I		
- setting context/ field	+F	+C
Stage II		
- ‘the everyday’ vs. ‘the scientific’	-F	-C
Stage III		
- modelling ‘scientific language’	+F	+C
Stage IV		
- setting context/ field	-F [^]	-C [^]
Stage V		
- ‘the everyday’ vs. ‘the scientific’	-F	-C
Stage VI		
- setting context/ field	+F	+C
Stage VII		
- modelling ‘scientific language’	+F	+C
Stage VIII		
- setting context/ field	+F	+C

KEY + stronger - weaker ^ sequence

Figure 4.1 Framework for ‘The Waves of Classification and Framing for Triadic Dialogue 8A’

To conclude, the following has been learnt from Triadic Dialogue 8A:

- 1) By strengthening the classification and framing in Triadic Dialogue 8A (*Stage I, Stage III, Stage VI, Stage VII* and *Stage VIII*) Mr. Maletto’s learners have gained new language and new understandings.
- 2) By weakening the classification and framing (*Stage II, Stage IV* and *Stage V*) Mr. Maletto has built a positive socio-affective disposition towards the text to be

produced. This is recognized to be important for ‘correct textual production’ (Morais and Neves, 2001).

- 3) And by weakening the classification and framing (*Stage II, Stage IV and Stage V*) Mr. Maleto’s learners tended to remain within ‘the everyday’ in terms of their understanding of force and did not progress towards ‘the scientific’, i.e. at the end of Triadic Dialogue 8A Mr. Maleto’s learners would not have been able to have explained why ‘a force does not necessarily make things to move’ in terms of ‘the scientific’ from Triadic Dialogue 8A.

In addition, it has been learnt that Mr. Maleto employs a number of resources to establish his authority in the classroom; that both Mr. Maleto and the learners are involved in establishing acceptable ways of talking science in the classroom; that scientific discourse is privileged in Mr. Maleto’s classroom and that the language Mr. Maleto’s learners are inducted into is at times idiosyncratic to him and his learners.

4.2 MORAL REGULATION FOR THE ACTIVITY TYPE TRIADIC DIALOGUE 9F

In Triadic Dialogue 9F²¹, *Stages I – VII*, I report on the analysis for the pedagogic discourse.

As discussed in 2.1.2, the pedagogic discourse involves a ‘moral regulation’ of the learners’ behaviour. In Triadic Dialogue 9F, the moral regulation of the learners’ behaviour, in terms of behaviour associated with what constitutes acceptably ‘good’ behaviour, and the moral regulation of the learners’ behaviour, in terms of behaviour associated with the induction of the learners into the verbal language of science, is revealed.

Secondly, as discussed in 2.1.5, a ‘pedagogic subject position’ is constructed in the pedagogic discourse. In Triadic Dialogue 9F, the pedagogic subject position, associated with acceptably ‘good’ behaviour and the verbal language of science, is revealed. (Christie, 2001).

In reporting on the pedagogic discourse in *Stages I - IV* the following is foregrounded:

- 1) The ‘moral regulation’ of the learners’ behaviour in terms of behaviour to do with what constitutes acceptably ‘good’ behaviour
- 2) The ‘pedagogic subject position’ constructed in the pedagogic discourse
- 3) The preparation of the learners and scaffolding provided for the learners to be ‘ideal pedagogic subjects’
- 4) The role of values in the regulation of the learners’ behaviour and in the construction of the ‘ideal pedagogic subject position’

In reporting on the pedagogic discourse in *Stages V- VII* the following is foregrounded:

²¹ Transcript 9F is included in Appendix B (pp.102 – 105).

- 1) The ‘moral regulation’ of the learners’ behaviour in terms of behaviour to do with the induction of the learners into the language of science
- 2) The ‘pedagogic subject position’ constructed in the pedagogic discourse
- 3) The language Mrs. McKenzie’s and Mr. Maletto’s learners are inducted into in the science classroom
- 4) The role of values and ideology in the regulation of the learners’ behaviour and in the construction of the ‘ideal pedagogic subject position’

A brief summary of the findings is then provided to conclude the section.

4.2.1 STAGE I

L1	T	RIGHT the LAST thing we are going to TALK about.. in the MECHANICS section #...
L2		(it’s getting quite hot in here today)
L3		RIGHT the LAST little bit that we do in the mechanics section #... is a little bit MORE than you did last year about..ENERGY...
L4	T	HOPEFULLY LAST YEAR # ..YOU learnt..SEVERAL different FORMS of ENERGY..
L5		DID you?
L6	Ls	yes
L7	T	maybe not LAST year..
L8		maybe..GRADE 8
L9	Ls	yes
		[a number of the learners talk at the same time]
L10	T	okay..grade 7 8 9...
L11		it # doesn’t MATTER...

In *Stage I*, the ‘pedagogic subject position’, namely a learner who is diligent, attentive and participates in the lesson, is constructed in the pedagogic discourse. Furthermore, Mrs. McKenzie prepares the learners to participate in the lesson.

Firstly, the ‘pedagogic subject position’ is constructed when Mrs. McKenzie uses the intensive process ‘is’ [L1] [also L2; L13 and L15] (in conjunction with positive polarity)

to state categorically what she and the learners are ‘to do’ [L3]. In addition, the learners are prepared to participate in Triadic Dialogue 9F when Mrs. McKenzie uses the intensive process ‘is’ [L1] to ‘pack in’ a large amount of information, i.e. when the success of the lesson depends on the learners’ grasp of what has been previously covered in the unit ‘energy’, and to signal the start of the Triadic Dialogue 9F. (Christie, 2002).

Secondly, the ‘pedagogic subject position’ is constructed when Mrs. McKenzie directs the course that Triadic Dialogue 9F takes (Christie, 2002 and Halliday, 1994). Mrs. McKenzie uses a cluster of textual theme choices, realized in the continuatives ‘**right**’ [L1] [also L3; L13 and L16] and ‘**now**’ [L16], to move Triadic Dialogue 9F forward.

Thirdly, the ‘pedagogic subject position’ is constructed when Mrs. McKenzie directs the pace at which Triadic Dialogue 9F unfolds. For example, initially, Mrs. McKenzie uses the Modal Adjunct ‘**maybe**’ [L7 and L8] to acknowledge the learners’ alternative voices, i.e. ‘grade 7’/ ‘grade 8’/ ‘grade 9’, around the claim L4 and to open up the space for negotiation. However, due to the learners’ indecisiveness and Mrs. McKenzie’s need to get through Triadic Dialogue 9F Mrs. McKenzie finally takes on the learners’ voices, using negation, in L11 and denies them. She states ‘**it doesn’t matter**’ [L11].

Lastly, the learners are prepared to participate in the lesson when Mrs. McKenzie uses the marked topical theme of time ‘**last year**’ [L4] to establish both some connectedness with the grade 9 general science curriculum and some sense of progression into the grade 10 physical science curriculum (Christie, 2002). She states ‘**hopefully last year # you **learnt** several different forms of energy**’ [L4].

L12	T	the different FORMS of energy..things..like..>HEAT energy, and SOUND energy, and LIGHT energy, and ELECTRICAL energy<..CHEMICAL energy...
L13		RIGHT the TWO we are going to talk about [is] #..
L14		< cause this # is a mechanics section >..
L15		the TWO we are going to talk about #..is POTENTIAL energy..and KINETIC energy

L16
L17

**RIGHT..NOW..let's # be MORE specific..
we # are going to talk about..<gravitational
potential energy>**

In *Stage I*, the 'pedagogic subject position', namely a learner who is specific when he/she 'talks' science, is also constructed in the pedagogic discourse. The 'pedagogic subject position' is constructed when Mrs. McKenzie uses the intensive process 'be' [L16] to ascribe the quality '**more specific**' [L16] to herself and the learners. Mrs. McKenzie states '**right now let's be more specific**' [L16]. L16 can be interpreted as 'x is a member of the class of a' (Halliday, 1994:120). Thus Mrs. McKenzie inducts the learners into science as 'members of the class of specific ones'.

In Triadic Dialogue 9F, classes [L12; L15; L16; L17 and L42] and parts [L95] are ascribed to energy as the 'pedagogic subject position', namely a learner who is specific when he/she 'talks' science, is constructed in the pedagogic discourse. As a result, a picture is built up of energy which becomes more and more specific. In L12 Mrs. McKenzie ascribes the classes 'heat'; 'sound'; 'light'; 'electrical' and 'chemical' to 'energy'. Then in L15 Mrs. McKenzie ascribes the classes 'potential' and 'kinetic' to energy. Lastly, in L17 Mrs. McKenzie ascribes the class 'gravitational potential' to potential energy. Thus the system network for energy (as represented in *Figure 4.2.1-1* below) is built in *Stage I*.

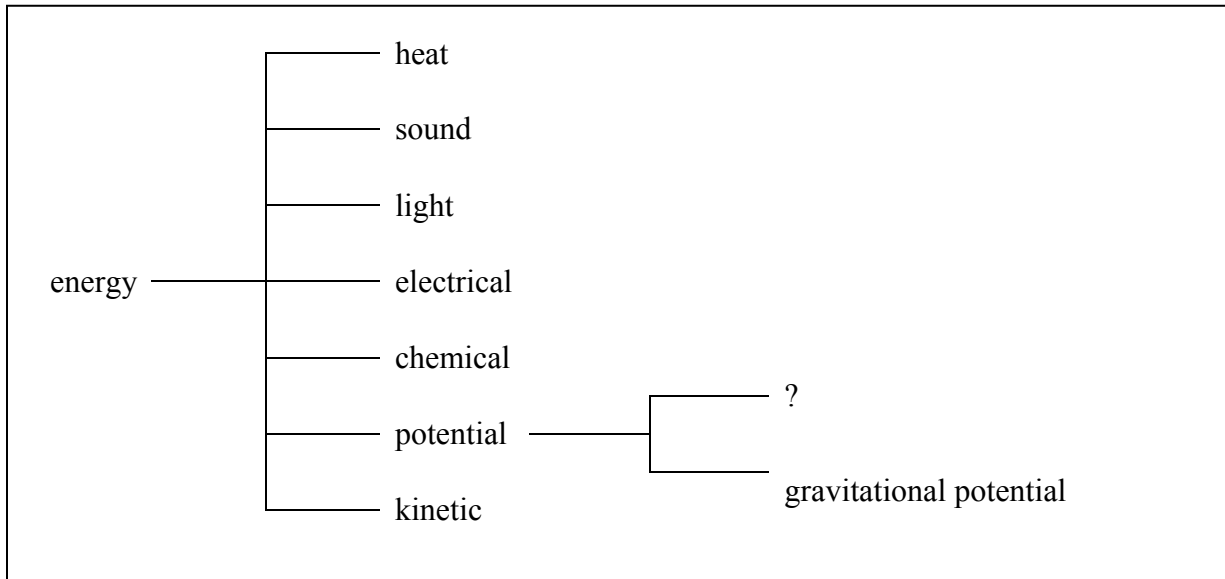


Figure 4.2.1-I The classifying taxonomy (represented by a system network) for energy built in Stage I

4.2.2 STAGE II

L18 **T** **now remember #**
 L19 **you # are doing your OWN notes, for your**
 OWN sakes,..
 L20 **so..SUBHEADING # would be ENERGY,**
 L21 **and then we # are going to talk about**
 gravitational POTENTIAL energy...
 L22 **REMEMBER #**
 L23 **some of you # put your notes into ROUGH**
 L24 **and then # put them into no- NEAT..**
 L25 **others of you # go straight into neat,..**
 L26 **it # 's up to YOU...**

In Stage II the regulative register [bold text] is foregrounded. When the regulative register is foregrounded the ‘pedagogic subject position’, namely a learner who is organized and works neatly, is constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed in *Stage II* when Mrs. McKenzie demands the following ‘goods and services’ – the learners are to take notes; the learners are to write the subheading ‘energy’ and the learners are to write neat notes. Interpersonally, these commands are expressed by the non-typical clause Mood declarative. Mrs. McKenzie states ‘**now remember you are doing your own notes for your own sakes**’ [L18-L19]; ‘**so subheading would be energy**’ [L20] and ‘**remember some of you put your notes into rough and then put them into neat others of you go straight into neat it’s up to you**’ [L22-L26].

In Lesson A, Mr. Maletto also expects his learners to work neatly and diligently. However, in comparison, Mr. Maletto writes notes for the preceding Triadic Dialogue on the chalkboard for the learners to copy. Therefore the learners in Mr. Maletto’s class have notebooks whereas the learners in Mrs. McKenzie’s class have jotters for their rough notes and files for their neat notes. In Lesson A, Mr. Maletto states ‘Now, okay, let’s write this thing down now, ne? All of us, okay? Lets’ consolidate here, ne? And write our notes down here...Date...please, ne? [punctuation added]’ [5.1A-5.5A].

Although the regulative register is foregrounded in *Stage II* the instructional field [plain text] for Triadic Dialogue 9F starts to be foreshadowed [L20 and L21]. As discussed in 2.1.2, the regulative register is therefore said to appropriate the instructional register in L20 and L21.

In *Stage II*, the ‘pedagogic subject position’, namely a learner who is responsible, is also constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed when Mrs. McKenzie uses the second person plural ‘**you**’ and possessive ‘**your**’ in the move Teacher Preparation. It is evident from her use of these resources that Mrs. McKenzie places the onus on the learners in Triadic Dialogue 9F to be responsible for their learning. Mrs. McKenzie states ‘**you are doing your own notes for your own sakes**’ [L19] and ‘**they’re your notes you are learning to keep notes one of your skills**’ [L31-L33] [also L23; L25; L26 and L30].

L27	T	>some people # write NOTHING,
L28		they # KNOW it already
L29		that # 's NOT a problem
L30		if YOU # know it already
L31		they # 're YOUR notes
L32		you # are learning to keep NOTES<
L33		ONE of your skills...

Finally, in *Stage II*, Mrs. McKenzie prepares the learners to be diligent and to take neat notes. In addition, she provides the learners with a reason for doing so.

Firstly, to prepare the learners to take notes, Mrs. McKenzie uses the continuative ‘**already**’ in L28 and L30 to counter the expectation that the field ‘gravitational potential energy’ is unknown territory. Mrs. McKenzie states ‘**some people write nothing they know it already**’ [L27-L28].

Secondly, to prepare the learners to take notes, Mrs. McKenzie uses negation in L29 to acknowledge the learners’ voice, i.e. ‘to not write notes is a problem’, and takes on that voice and denies it. Mrs. McKenzie states ‘**some people write nothing they know it already that’s not a problem**’ [L27-L29].

Lastly, Mrs. McKenzie provides the learners with a reason for taking notes when she states ‘**you are learning to take notes one of your skills**’ [L32-L33]. Mrs. McKenzie (Journal, April, 19, 2006) stated that one of her primary concerns in the implementation of OBE in grade 10 physical science was to teach the learners skills that they would use later on at university and in the workplace. This is in line with one of the nine principles, namely “high knowledge and high skills”, which underlie the National Curriculum Statement Grades 10 – 12 (General) Physical Science (South Africa, 2003:1).

4.2.3 STAGE III

L34	T	RIGHT can anybody # remember another similar NAME for potential energy?
L35	L₁	still energy
L36	T	say # that loudly?
L37	L₁	still energy
L38	T	not still
L39		it # begins with an s though

In *Stage I* and *Stage II*, the ‘pedagogic subject position’, namely a learner who is diligent and participates in the lesson, is constructed in the pedagogic discourse. In addition, Mrs. McKenzie prepares the learner to participate in Triadic Dialogue 9F. In *Stage III*, however, Mrs. McKenzie scaffolds the learners so that the learners are able to participate in Triadic Dialogue 9F.

Firstly, Mrs. McKenzie fosters a ‘safe’ learning environment where the learners are willing to take moderate risks.

For example, when a learner incorrectly answers ‘still energy’ [L35] to the question ‘**can anybody remember another similar name for potential energy?**’ [L34] Mrs. McKenzie prevents the learner from ‘losing face’ (Chick, 1996) by using concession [L39] to counter the learners’ expectation that the answer is ‘completely’ incorrect. Mrs. McKenzie light-heartedly remarks ‘it begins with an s though’ [L39].

L40	T	s t?..
L41	Ls	<u>stored energy</u> . [a couple of learners call out ‘stored energy’]
L42	T	<u>STORED energy</u> .
L43	L₁	oh yes

Secondly, Mrs. McKenzie enforces ‘rules’ governing participation in the lesson so that the learners know how to participate.

For example, when Mrs. McKenzie continues to prompt the learner to respond by stating ‘s t?’ [L40] other members of the class call out ‘stored energy’ [L41] instead. As a result Mrs. McKenzie, in the move Teacher Follow-up, simultaneously (and loudly) states ‘stored energy’ [L42]. Mrs. McKenzie is therefore able to maintain the rule that learners need to be called on in the move Teacher Nomination before they can legitimately answer. (Lemke, 1993).

In Lessons F and G Mrs. McKenzie is not consistent about maintaining the rule that there should be Bids and Nomination before a Response (Lemke, 1993). However, by ignoring the learners’ response in L41, Mrs. McKenzie is able to maintain discipline and her power in the class to decide who will answer (Lemke, 1993). A further example, where Mrs. McKenzie expected the learners to abide by the rule ‘Bids followed by Nomination’, is provided in Lesson G [5.4G-5.7G]. Mrs. McKenzie states:

T hands up those who can tell me what the mechanical energy is at the top
L₁ ten thousand
T aye where’s your hand [name]
L₂ ten thousand

L44	T	RIGHT..NOW..you # CAN get STORED in TERMS of things like..a SPRING
L45		all of you # think of a spring...
L46		WHEN a SPRING # is PUSHED in TIGHT...
L47		IT # ’s got the potential..TO?
L48	Ls	expand [a couple of learners call out ‘expand’]
L49	T	..expand
L50		and # spring out
L51		hasn’t it

Thirdly, Mrs. McKenzie engages the learners and provides the learners with multiple opportunities to use the key lexical items.

For example, in L47 Mrs. McKenzie uses a rising intonation in the move Teacher Initiation to prompt the learners to provide the key lexical item ‘expand’ [L48]. In the Activity Type Triadic Dialogue Mrs. McKenzie and Mr. Maletto often employ a rising intonation followed by a brief pause to engage the learners and provide the learners with multiple opportunities to use the key lexical items. As a result the Activity Type Triadic Dialogue resembles a Cloze Type Activity. Cloze Type Activities are used to support learners’ language learning in the bilingual classroom (Clegg, Rea-Dickens and Kiely, 2004; Henderson and Wellington, 1998; South Australia, 1999). Further examples for Triadic Dialogue 9F are L80; L97; L100; L108; L109; L133 and L138.

Finally, as the learners participate in the lesson the system network for ‘energy’ expands by one more thematic item, namely ‘stored potential energy’, in *Stage III* (Figure 4.2.3-I).

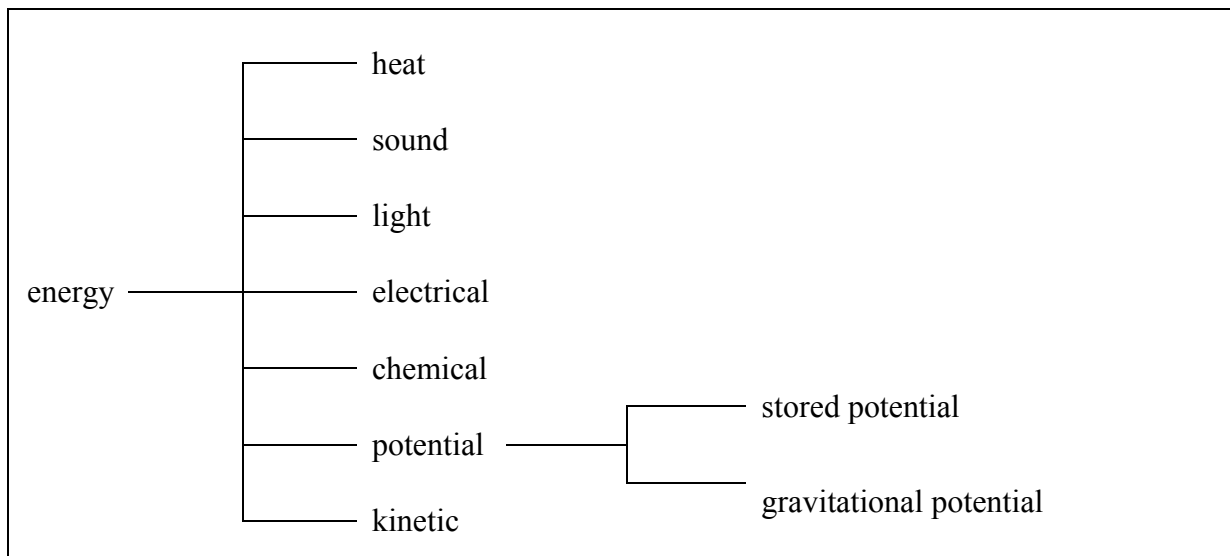


Figure 4.2.3-I The classifying taxonomy (represented by a system network) for energy built in *Stage I* and *Stage III*

4.2.4 STAGE IV

L52 **T** **RIGHT..YOU LOT # have ALL got the POTENTIAL..to pass matric..to develop your**

L53	GREY cells..to do well..in LIFE
L54	you # 've all got the potential...
L55	it # doesn't mean you're all going to,..
L56	that # 's UP to EACH and every ONE of you,..
L57	hopefully each and every one of you # ARE
	going to,..
	BUT you # 've GOT the POTENTIAL..

In *Stage IV* the regulative register [**bold text**] is foregrounded. When the regulative register is foregrounded the ‘pedagogic subject position’, namely a learner who is accountable, is constructed in the pedagogic discourse.

‘Accountability’ is one of the six values named in *The Manifesto on Values, Education and Democracy* (South Africa, 2000a). The value of ‘accountability’ in *The Manifesto on Values, Education and Democracy* (South Africa, 2000b:5) emphasizes “educator and learner responsibility and excellence [emphasis mine] as well as [the] legitimate and the vibrant democratic governance of schools”.

In *Stage VI* the learners are taught that they have the potential to succeed but whether or not they succeed is dependent upon them. Mrs. McKenzie states ‘**you lot have all got** the potential **to pass Matric, to develop your grey cells, to do well in life**’ [L52] and ‘**it doesn't mean you're all going to** [succeed] **that's up to each and every one of you**’ [L54-L55]. The learners are thus taught that they are individually responsible for their successes and failures (Lemke, 1993).

In Lessons A – I Mrs. McKenzie and Mr. Maletso also promote the value of ‘accountability’.

In Lesson F Mrs. McKenzie holds the learners accountable for their homework – the learners’ homework is to transfer their notes from rough into neat and to file them. Mrs. McKenzie states ‘ladies keep your files properly all the time...you should be able to produce it any time’ [3.1F-3.2F]. In terms of accountability (to do with homework) *The Manifesto on Values, Education and Democracy* (2000a:43) states “The monitoring and

scrutiny of homework set regularly are an estimable recognition of the worth of the learner.”

In Lesson A and Lesson B Mr. Maletto holds the learners accountable for homework as well as for school attendance. Mr. Maletto states ‘I swear I don’t go along with learners who don’t study you know who don’t go through their work’ [1.62B-1.63B] and ‘people you have got to be here you have got to be here you have got to be here’ [18.1A-18.2A]. In terms of accountability (to do with school attendance) *The Manifesto on Values, Education and Democracy* (2000a:43) states “Absenteeism without demonstrably legitimate medical or other reason is a dereliction of duty.”

4.2.5 STAGE V

L58	T	right..NOW..<GRAVITATIONAL potential energy>..
L59		you # can define it as <ENERGY due to HEIGHT> specifically
L60		so like the energy in a SPRING # ..wouldn’t come under <GRAVITATIONAL potential energy>..
L61		okay gravitational potential energy # is <ENERGY due to HEIGHT>...
L62		the other way of talking of potential energy when you were in grade 9 # is...position
L63		°sometimes you # may have used that word energy due to position°..
L64		but what we’re going to think of THIS year # is ENERGY due to HEIGHT..
L65		CAUSE it # ’s GOT the GRAVITY bit in...
L66		um..WHERE # ’s that?
L67		OKAY..here # ’s her ERASER...
L68		is it # MOVING?
L69	Ls	no
L70	T	what # sort of ENERGY did it have up there?
L71	Ls	potential energy
L72	T	GRAVITATIONAL potential energy
L73	Ls	oh
L74	T	okay..you # can just call it potential energy
L75		but..bear # in the back of your minds

L76

that it # 's GRAVITATIONAL potential energy..<ENERGY due to HEIGHT>..

In *Stage V*, the instructional register is foregrounded. When the instructional register is foregrounded the ‘pedagogic subject position’, namely a learner who is able to marshal the correct scientific term and deploy it in ‘talking’ science as well as being able to define the scientific term, is constructed in the pedagogic discourse.

Firstly, the ‘pedagogic subject position’ is constructed when Mrs. McKenzie teaches the learners the scientific terms for *Stage V* and their respective definitions. In *Stage V* the learners are taught the key lexical item ‘gravitational potential energy’ [L58]. In addition, the learners are taught to define ‘gravitational potential energy’. Mrs. McKenzie states ‘**you can define** it [gravitational potential energy] **as** energy due to height’ [L59] (*Figure 4.2.5-I*).

you	can define	it	as	energy due to height
Assigner	Pro-	Token	cess	Value

Figure 4.2.5-I Analysis of Transitivity for L59

Secondly, the ‘pedagogic subject position’ is constructed when Mrs. McKenzie insists on the learners using the scientific terms accurately. When the learners respond ‘potential energy’ [L71] to the question ‘what sort of energy did it [the eraser] have up there?’ [L70] Mrs. McKenzie restates the learners’ response as ‘gravitational potential energy’ [L72] and stresses the word ‘gravitational’ [L72].

However, it is evident from *Stage V* that Mrs. McKenzie also constructs acceptable ways of ‘talking’ science with the learners. To construct acceptable ways of ‘talking’ science with the learners Mrs. McKenzie uses the resource of modality. Mrs. McKenzie states ‘**you can define** it **as** energy due to height’ [L59] [also ‘**so like** the energy in a spring **wouldn’t come under** gravitational potential energy’ [L60]; ‘**sometimes you may have**

used that word energy due to position’ [L63] and ‘you **can just call** it potential energy’ [L74].

Lastly, the ‘pedagogic subject position’ is constructed in *Stage V* when Mrs. McKenzie refers to how a grade 10 physical science learner ‘talks’ science differently to a grade 9 general science learner. Mrs. McKenzie states in L62 ‘**the other way of talking of potential energy when you were in grade 9 is position**’ and then in L64 ‘**but what we’re going to think of this year is energy due to height**’. Furthermore, the language used in grade 10 (*Figure 4.2.5-II*) places greater demands on the learners than the language used in grade 9 (*Figure 4.2.5-III*) due to the additional modification of the nominal group, where ‘energy’ is ‘Thing’.

potential energy	is	energy due to position
Token	Pr: intensive	Value

Figure 4.2.5-IIA Analysis of Transitivity for L62-L63

potential	energy
Classifier	Thing
Premodifier	Head
β^{22}	α

←

Figure 4.2.5-IIB Nominal group with Classifier

energy	due to position
Thing	Qualifier
Head	Postmodifier
α	β

→

Figure 4.2.5-IIC Nominal group with phrase as Qualifier

Figure 4.2.5-II Analysis for L62-L63

²² Letters of the Greek alphabet are used to indicate degrees of modification for the nominal group.

gravitational potential energy	is	energy due to height
Token	Pr: intensive	Value

Figure 4.2.5-III A Analysis of Transitivity for L64

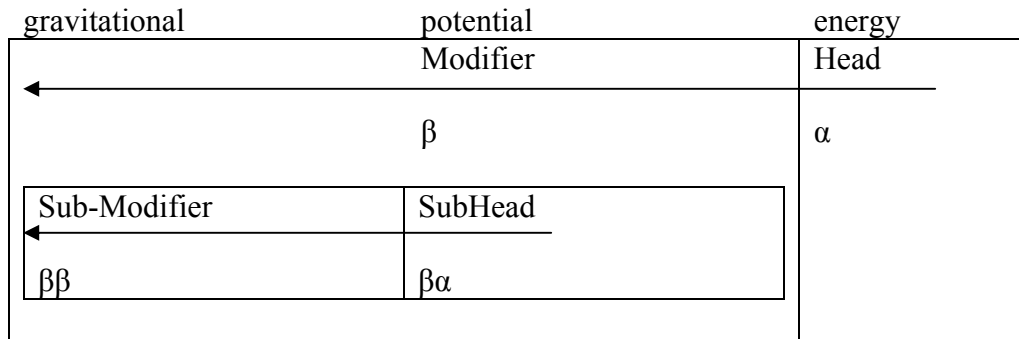


Figure 4.2.5-III B Nominal group with submodification

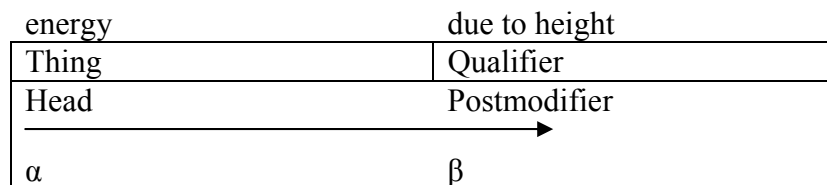


Figure 4.2.5-III C Nominal group with phrase as Qualifier

Analysis 4.2.5-III Analysis for L64

The ‘thematic pattern’ (Lemke, 1993) for ‘potential energy’ (as shown in *Figure 4.2.5-IV* below) is thus completed in *Stage V* when the learners are taught the key lexical item ‘gravitational potential energy’ and to define it. As a result, the learners are able to make sense of the ‘thematic item’ (Lemke, 1993) ‘gravitational potential energy’ [L58] in relation to the ‘thematic item’ ‘stored potential energy’ [L42]. Lemke (1993:12) states:

The science in the dialogue is not just a matter of vocabulary. Classroom language is not just a list of technical terms, or even just a recital of definitions. It is the use of those terms in relation to one another, across a wide variety of contexts.

As ‘potential energy’ is ambiguous, i.e. it can be defined as ‘stored energy’ as well as ‘energy due to height’, Mrs. McKenzie expends a lot of effort to build the ‘thematic pattern’ (as shown in *Figure 4.2.5-IV* below) in *Stages III – V*. Mrs. McKenzie uses the example of a spring [L44] and the analogy of the learners’ potential [L52] to explain ‘stored energy’. Furthermore, she uses the example of an eraser [L67] and a waterfall [L80] to explain ‘energy due to height’.

Mrs. McKenzie also refers directly to this ambiguity. In *Stage V* [L74-L76] Mrs. McKenzie makes the distinction between ‘what the learners say’ and ‘what the learners mean’ when the learners use ‘potential energy’. Mrs. McKenzie states ‘Okay, you can just call it potential energy but bear in the back of your minds that it’s gravitational potential energy, energy due to height.’ [punctuation added] [L74-L76].

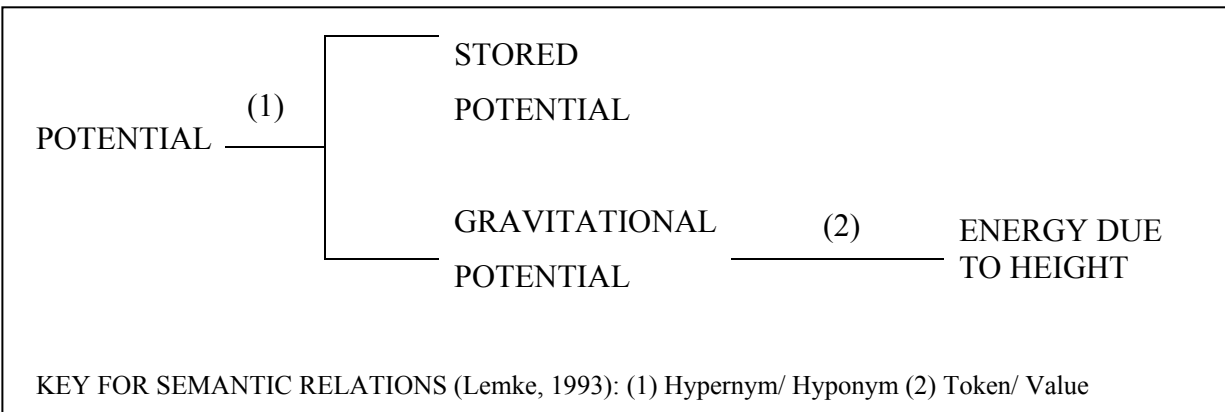


Figure 4.2.5-IV Thematic Pattern for Potential Energy

However, in Lessons A – I Mrs. McKenzie and Mr. Maletto are not always aware that the language used is ambiguous. This has implications for the induction of the learners into the language of science and for the ‘pedagogic subject position’ constructed in the pedagogic discourse.

For example, the phrase ‘force of the earth’ and ‘force of the surface’ used in Lessons A – I are ambiguous. As a result Mrs. McKenzie uses ‘force of the surface’ [2.7G] for

‘force A’ in *Figure 4.2.5-V* whereas Mr. Maleto uses ‘force of the surface’ [9.21I-9.22I] for ‘force B’ in *Figure 4.2.5-V*. In addition, it is evident (from past exam papers Mrs. McKenzie has marked) that learners have used ‘force of the earth’ and ‘force of the surface’ differently. In Lesson G [2.48G-2.51G] Mrs. McKenzie states:

I can’t tell you how many times I’ve seen exam papers [scripts] with arrows pointing up for the force of the earth [emphasis mine] which is obviously not you know if I drop my pen [Mrs. McKenzie drops her pen] what does it do it goes down the earth pulls on it right

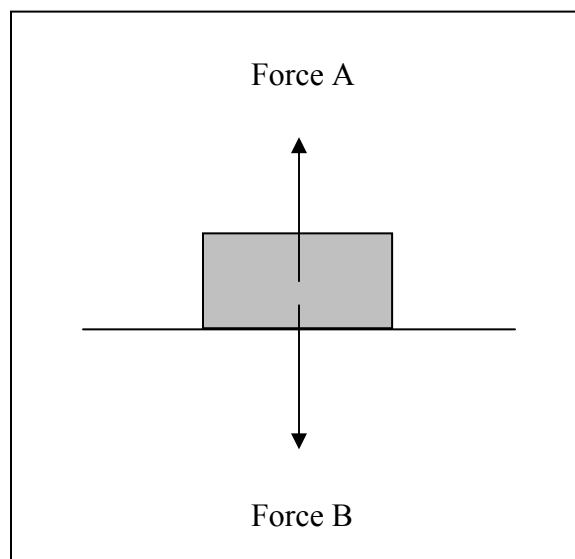


Figure 4.2.5-V The phrase ‘force of the earth’ and ‘force of the surface’ as used by Mrs. McKenzie and Mr. Maleto

‘Force of the earth’ and ‘force of the surface’ are ambiguous because of lexical and grammatical ambiguity (Halliday, 1989). Firstly, the key lexical items ‘surface’ and ‘earth’ are ambiguous. Mrs. McKenzie interprets ‘surface’ as ‘the substance of the land surface’ whereas Mr. Maleto interprets ‘surface’ as ‘the planet on which we live’. Furthermore, learners (in past exams marked by Mrs. McKenzie) have interpreted ‘earth’ as ‘the substance of the land surface’. (Oxford English Dictionary). Secondly, the grammar of ‘force of the earth’ and ‘force of the surface’ is ambiguous. ‘Force of the earth’ and ‘force of the surface’ are nominal groups. When clausal expressions are

replaced with nominal ones a great deal of semantic information is lost. This is known as ‘syntactic ambiguity’. Halliday (1989:170) states (with regards to ‘syntactic ambiguity’):

It may seem obvious to the writer, and also to the teacher, which meaning is intended; but it is far from obvious to a learner, and the teacher and learner may interpret the passage differently without either of them being aware that another interpretation was possible.

The ambiguity of ‘force of the earth’ is compounded as Mrs. McKenzie and Mr. Maletto use the following interchangeably: ‘force of the earth’ [2.35G]; ‘weight’ [2.35G]; ‘gravitational force’ [10.13A]; ‘the force exerted by gravity’ [10.17A]; ‘force of gravity’ [2.44G]; and ‘gravity’ [15.29H]. In comparison the textbook states “**It is important to note that the term weight only applies on earth.** On other planets we refer to the gravitational force.”

Furthermore, the definition provided by Mrs. McKenzie for ‘weight’ is ambiguous. In the ‘delocation’, ‘relocation’ and ‘transmission’ of the definition for ‘weight’, a space has been created in which ideology can play, and the definition for weight has been transformed (Bernstein, 2000 and Christie, 2002). Mrs. McKenzie omits ‘with which a body is attracted to the centre’ from the definition provided in the textbook for weight. Mrs. McKenzie states ‘weight’ is ‘the force of the earth’ [2.35G]. The definition provided in the textbook for ‘weight’ is “Weight is the force with which a body is attracted to the centre of the earth.”

Definitions in Mr. Maletto’s class are also transformed in the ‘delocation’, ‘relocation’ and ‘transmission’ of the instructional field (Christie, 2002). In Lesson A Mr. Maletto states

Never say change in displacement. Right, I know books say that. They are wrong [emphasis mine]. You see you can’t change a change in position because the word displacement itself means what change in position. So I can’t say velocity is the rate of change of displacement. It is just the rate of what of change of position. [repetitions omitted] [punctuation added] [15.1A-15.5A]

To summarize, the possible implication for the ‘pedagogic subject position’ is that the ‘pedagogic subject position’ constructed in the pedagogic discourse will be a learner who is able to ‘talk’ science in ways that are to some degree idiosyncratic to a teacher and his/her learners.

Furthermore, it is evident from Lessons A – I that in the induction of the learners into the language of science misunderstandings take place, learners are penalized because of these misunderstandings, and the teacher and the learners sometimes grapple with the language of science due to its ambiguous nature.

L77	T	SO IT# ’s GOT the POTENTIAL to do WHAT?
L78	Ls	to fall down
L79	T	°to fall down°..
L80	T	alright WATER # at the TOP of a WATERFALL...HAS?
L81	Ls	(gravitational) potential energy
L82		potential energy..gravitiational potential energy
L83		alright ..ANYTHING that is at a HEIGHT..compared to something else # ..
L84		alright?
L85		has got potential energy

Finally, in *Stage V* the ‘pedagogic subject position’, namely a learner who is able to marshal the correct scientific term and deploy it in a context where the thematics are deemed appropriate, is constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed in *Stage V* when Mrs. McKenzie chooses an example that she considers appropriate for her learners and where the thematics are in line with the values she wishes to instill in her learners (Lemke, 1993). The example Mrs. McKenzie chooses to explain ‘gravitational potential energy’ [L82] is that of a ‘waterfall’ [L80].

However, it is evident in Lessons A – I that in the regulation of the learners’ behaviour there may be a conflict of values. In Lesson G, for example, Mrs. McKenzie gives an

assessment task for her learners to do in their groups where the learners are required to choose their own example to explain ‘gravitational potential energy’. Mrs. McKenzie [8.6G-8.10G] states:

your group has got to make up a question with a situation you can’t have a diver or a brick [emphasis mine] because I’ve used the diver and the brick okay you’ve got to make up a situation alright and you’ve got to make up a question that’s going to be worth ten marks

An example of the learners’ work is provided in *Figure 4.2.5-VI* below.

The image shows a student's handwritten work on a grid. On the left side, there are four rows representing floors of a building, labeled from top to bottom: '4th floor', '3rd floor', '2nd floor', and '1st floor'. To the right of each floor, there are two columns for energy: 'E_p = ___' and 'E_k = ___'. The student has drawn stick figures on the grid, one on the 4th floor and one on the 1st floor. Below the grid, the student has written: '[name] I wanted to commit suicide by jumping from a 4 storey building. Poor choice of scenario'.

[name] wanted to commit suicide by jumping from a 4 storey building
Poor choice of scenario

Figure 4.2.5-VI An example of learners’ work completed for Assessment Task; Lesson G

Mrs. McKenzie remarks ‘poor choice of scenario’ on the learners’ work. In addition, the learners are given a grade of 30%.

Although the learners are able to marshal the correct scientific terms and deploy them in Lesson G, the learners fail to choose an example where the thematic are deemed

appropriate. As a result the learners are penalized by being awarded a poor grade and receiving negative feedback. Lemke (1993:48) states:

The conflicts between teachers and students over proper behaviour and proper thematics [emphasis mine] are also value conflicts... These value conflicts are not peculiar to the classroom... They are the value conflicts in our society between older and younger [emphasis mine]; the middle-class and the poor; male and female; white and black; one ethnic tradition and another.

It is thus evident that the teacher's values play an important role in the regulation of the learners' behaviour and in the construction of the 'pedagogic subject position' in the pedagogic discourse.

4.2.6 STAGE VI

L86	T	okay..NOW what about the second one we're going to [unclear] which is <KINETIC energy>...
L87		kinetic energy # is what sort of energy?
L88	Ls	[unclear]
L89	T	<ENERGY due to MOVEMENT>
L90		right as soon as there # 's MOVEMENT
L91		there # is KINETIC energy...

In *Stage VI* (as in *Stage V*) the 'pedagogic subject position', namely a learner who is able to marshal the correct scientific term and deploy it in 'talking' science as well as being able to define the scientific term, is constructed in the pedagogic discourse.

The 'pedagogic subject position' is constructed in *Stage VI* as the learners piece together (from the classroom talk in L66 – L91) the 'semantic relation' (Lemke, 1993) for 'kinetic energy' [L86] provided in *Figure 4.2.6-I* below.

kinetic energy	is	energy due to movement
Token	Pr: intensive	Value

Figure 4.2.6-IA Analysis of Transitivity for L90-L91

kinetic	energy
Classifier	Thing
Premodifier	Head
β	α

←

Figure 4.2.6-IB Nominal group with Classifier

energy	due to movement
Thing	Qualifier
Head	Postmodifier
α	β

→

Figure 4.2.6-IC Nominal group with phrase as Qualifier

Figure 4.2.6-I Analysis for L90-L91

4.2.7 STAGE VII

- L92 **T** AND then TOGETHER # what are gravitational potential energy and kinetic energy called?
- L93 **L(s)** (yoh..gravitational potential kinetic energy)
[a number of the learners attempt to come up with names]
- L94 **T** **some strange names coming out of here today...**
- L95 <KINETIC energy..and POTENTIAL energy # together...make MECHANICAL energy>...
- L96 **T** **RIGHT let's # think AGAIN..about the WATER at the top of a WATERFALL..**
- L97 and it # 's going to?..FALL down...
- L98 you # can't LOSE
- L99 or # gain energy

L100 it # gets?
L101 **Ls** transferred
L102 **T** TRANSFERRED,
L103 >**some books # say** TRANSFORMED,
L104 **some books # say** CHANGED
L105 **I # don't mind which WORD you USE<...**
L106 it # can get CHANGED from ONE form,..to ANOTHER...
L107 **T** SO..for the WATER for the WATERFALL or her ERASER...
L108 it # STARTED with?..
L109 potential energy what in the end changed into?
L110 **Ls** kinetic energy
L111 **T** KINETIC energy [L112-L124 omitted]
L125 **T** °**don't put** your eraser **away**
L126 **we # 're using** this eraser°
L127 **T** **ALRIGHT** at the TOP HERE
L128 is it # MOVING?
L129 **Ls** no
L130 **T** so the mechanical energy # is ALL potential..
L131 HALFWAY DOWN..
L132 so it # 's going from THERE to the DESK..
L133 HALFWAY DOWN # ..HALF will be kinetic..
L134 and # HALF will be?..
L135 **Ls** potential
L136 **T** POTENTIAL
L137 and at the BOTTOM # ..now it's got NO potential
L138 it # 's not going to fall any further
L139 all the mechanical energy # is?
L140 **Ls** kinetic energy
[a couple of learners call out 'kinetic energy']
L141 **T** KINETIC energy
L142 the table # is going to stop it...
[the bell rings]

In *Stage VII* (as in *Stage V* and *Stage VI*) the 'pedagogic subject position', namely a learner who is able to marshal the correct scientific term and deploy it in 'talking' science, is constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed when Mrs. McKenzie insists on the learners using the scientific terms accurately. However (as in *Stage V*) Mrs. McKenzie constructs acceptable ways of ‘talking’ science with the learners in *Stage VII*.

For example, in *Stage VII* Mrs. McKenzie introduces multiple voices into the text, namely ‘transformed’ [L103] and ‘changed’ [L104], via projection, and attributes the source of the projections to ‘some books’ [L103 and L104]. Then, Mrs. McKenzie uses the resource of negation to take on the learners’ voice, namely ‘it matters which word you use’, and denies it. Mrs. McKenzie states ‘**I don’t mind which word you use**’ [L105]. As a result, there is weaker framing in terms of the ‘correct’ scientific term to be marshaled and deployed in *Stage VII*.

In addition, Mrs. McKenzie fosters a learning environment, in *Stage VII*, in which humour plays an important role in the induction of the learners into the language of science.

For example, when Mrs. McKenzie asks the learners ‘and then together what are gravitational potential energy and kinetic energy called?’ [L92] a learner(s) remarks ‘yoh gravitational potential kinetic energy’. Furthermore, in response, Mrs. McKenzie light-heartedly remarks ‘**some strange names coming out of here today**’ [L94] using the resource of ‘Appraisal’ (Martin and Rose, 2003) to express her attitude towards the learners’ efforts. In Lessons A – I humour also plays an important role in Mr. Maletto’s classroom in the induction of the learners into the language of science. In Lesson A, Mr. Maletto actually encourages the learners to ‘play’ with the language of science. For example, a learner replies ‘A velometer?’ when Mr. Maletto asks the question ‘The speed you read on a speedometer, the velocity?’ [13.72A-13.74A]. It is thus evident from Lessons A – I that humour and a sense of ‘playfulness’, play an important role in the induction of the learners into the language of science.

Secondly, in *Stage VII*, the ‘pedagogic subject position’, namely a learner who is able to marshal the correct ‘rule’ and deploy it when ‘talking’ science, is constructed in the

pedagogic discourse. The ‘pedagogic subject position’ is constructed in *Stage VII* when the learners provide the principle of the Conservation of Energy [L98 – L102] in a whole class prompted cloze chorus. The learners evidently have been taught the principle of the Conservation of Energy. In addition, the learners have been taught this principle as fact, plain and simple and not to be argued with (Lemke, 1993:137).

It is thus evident that the ideology of the objective truth of science permeates Triadic Dialogue 9F and plays an important role in the regulation of the learners’ behaviour (i.e. it goes questioned) and in the construction of the ‘pedagogic subject position’ in the pedagogic discourse.

L143	T	THINK # of EXAMPLES TONIGHT PLEASE,
L144		I # ’m going to ASK you for EXAMPLES TOMORROW,
L145		OFF you GO LADIES

Finally, in *Stage VII* it is evident that the pedagogic discourse involves a ‘moral regulation’ of the learners’ behaviour both within and outside the context of the classroom. Interpersonally and experientially Mrs. McKenzie uses a grammatically congruent command and process of cognition when she states ‘**think of examples tonight please**’ [L143] as the bell rings to signal the end of class. Furthermore, a teacher’s preoccupation with time is also evident in ‘**think of examples tonight please I’m going to ask you for examples tomorrow**’ [L143-L144] in the regulation of the learners’ behaviour (Christie, 2002).

CONCLUSION

In *Stages I – IV* the regulative register is foregrounded and the pedagogic discourse involves a ‘moral regulation’ of the learners’ behaviour (in terms of behaviour to do with what constitutes acceptably ‘good’ behaviour).

The 'ideal pedagogic subject position' (Christie, 2001) for *Stages I – IV* is a learner who is: diligent (*Stage I*); attentive (*Stage I*); participates in the lesson (*Stage I*); responsible (*Stage II*); organized (*Stage II*); works neatly (*Stage II*) and accountable (*Stage IV*).

The 'ideal pedagogic subject position' is constructed in the pedagogic discourse when Mrs. McKenzie:

- 1) States categorically what she and the learners are 'to do';
- 2) Directs the course of the dialogue;
- 3) Directs the pace of the lesson;
- 4) Places the onus on the learners to be responsible for their learning;
- 5) Expects the learners to be organized and to write neat notes;
- 6) And refers directly and indirectly to the 'ideal pedagogic subject position'.

Finally, Mrs. McKenzie prepares the learners and scaffolds the learners so that the learners are able to participate in Triadic Dialogue 9F; Mrs. McKenzie:

- 1) Focuses the learners' attention on key ideas and establishes some form of connectedness between key ideas;
- 2) Establishes a safe learning environment in which the learners are comfortable to take moderate risks;
- 3) Establishes 'rules' for participation in the lesson;
- 4) And engages the learners and provides them with multiple opportunities to use the key lexical items.

Although the regulative register is foregrounded in *Stages I - IV*, the instructional field for Triadic Dialogue 9F starts to be foreshadowed (Christie, 2002). In *Stages V – VII* the instructional register is foregrounded and there is a 'moral regulation' of the learners' behaviour (in terms of behaviour to do with the induction of the learners into the language of science).

The 'ideal pedagogic subject position' for *Stages V – VII* is a learner who is able to marshal the correct scientific term or 'rule' and deploy it in 'talking' science, as well as provide the correct definition for a scientific term. In addition, the 'ideal pedagogic subject position' is a learner who is specific when he/ she 'talks' science.

The 'ideal pedagogic subject position' is constructed in the pedagogic discourse when Mrs. McKenzie:

- 1) Teaches the learners the scientific terms and their respective definitions;
- 2) Insists on the scientific terms being used accurately;
- 3) And refers directly and indirectly to the 'ideal pedagogic subject position'.

Although the 'ideal pedagogic subject position' is a learner who is able to marshal the correct scientific term and deploy it, it is also evident from *Stage V* and *Stage VII* that Mrs. McKenzie constructs acceptable ways of 'talking' science with the learners.

Finally, values and ideology were shown to play an important role in the regulation of the learners' behaviour and in the construction of the 'ideal pedagogic subject position'.

4.3 MORAL REGULATION FOR THE ACTIVITY TYPE TRIADIC DIALOGUE 1B

In Triadic Dialogue 1B²³, *Stages I – VII*, I report on the analysis of the pedagogic discourse.

As discussed in 2.1.2, the pedagogic discourse involves a ‘moral regulation’ of the learners’ behaviour. In Triadic Dialogue 1B, the ‘moral regulation’ of the learners’ behaviour (in terms of behaviour associated with the induction of the learners into the ‘languages’ (Lemke, n.d.b) of science) is revealed. (Christie, 2002).

As discussed in 2.1.5, a ‘pedagogic subject position’ is constructed in the pedagogic discourse. In Triadic Dialogue 1B, the ‘pedagogic subject position’ (associated with multimodal literacies) is revealed. (Christie, 2001).

In reporting on the pedagogic discourse in *Stages I – VII* the following is foregrounded:

- 1) The ‘moral regulation’ of the learners’ behaviour in terms of behaviour to do with the induction of the learners into the ‘languages’ of science;
- 2) The ‘pedagogic subject position’ (to do with multimodal literacies) constructed in the pedagogic discourse;
- 3) The verbal (*Stage II* and *Stage III*); mathematical (*Stage VI*) and visual literacies (*Stage VII*) Mr. Maleto’s learners are inducted into in the science classroom;
- 4) The implicit and explicit teaching of multimodal literacies;
- 5) And the ‘positioning’ and ‘repositioning’ of the learners as ‘pedagogic subjects’ in the science classroom.

A brief summary of the findings is then provided to conclude the section.

²³ Transcript 1B is included in Appendix B (pp.35 – 40).

4.3.1 STAGE I

K1	T	what # TYPE of vector addition did we do?	
K2		the FIRST type of addition	
K3		now we we # said	
K4		vectors # can ACT..	
K5		HOW # can vectors act?..	[K6 omitted]
K7		in which..in which # WAY can vectors ACT?	
K8	L₁	in a certain direction	
K9	T	no no okay YES?..YES?..	
K10		let the whole class.. # HEAR what you are saying	
K11	L₁	I # 'm saying	[K12-K13 omitted]
K14		that they # can ACT in the same direction	
K15	T	vectors # can ACT in the same direction..	
K16		do you # ALL agree?	
K17	Ls	yes	

In Triadic Dialogue 1B the regulative and instructional register are intimately associated when Mr. Maleto and the learners solve a problem on vector addition.

The methods used to solve the problem on vector addition (realized through the regulative register) are determined by how the vectors are acting, i.e. in a straight line or at an angle (realized through the instructional register).

Firstly, in *Stage I* [K1-K17], the classifying taxonomy for vector addition, realized through the instructional register, is introduced (*Figure 4.3.1-I* below).

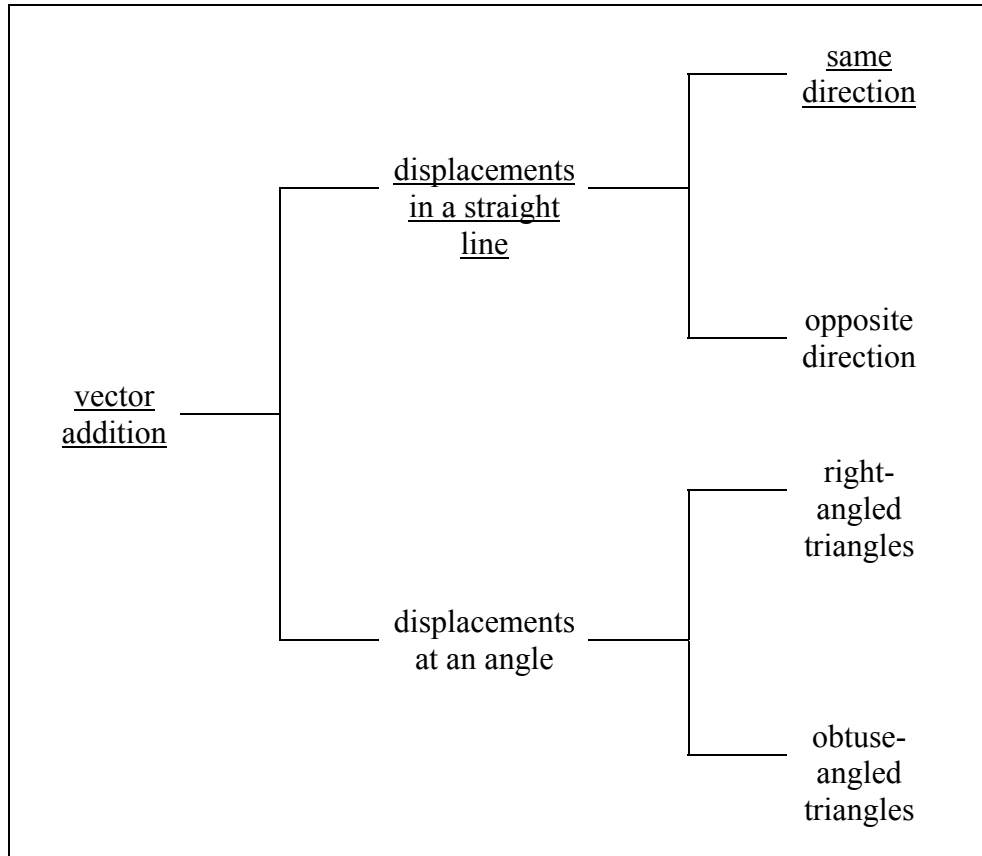


Figure 4.3.1-I The classifying taxonomy (represented by a system network) for vector addition built in Lessons B – E

K18	T	yes..	
K18		now if vec-	
K20		yes?	
K21	L	vectors # can act in an OPPOSITE direction	
K22	T	okay FINE..	
K23		we # are coming there	
K24		ne?	
K25	T	right vectors # can act on the op- in the same direction	
K26		now we # said	
K27		if they # 're ACTING in the same direction...	
K28		what # is the ANGLE between the vectors?..	
K29		yes [name]?	
K30	L	it # 's zero sir	
K31	T	the ANGLE between the vectors # is ZERO..	[K32-K34 omitted]
K35		now I # think	

K36		I # made something like THIS,..
K37		I # said
K38		OKAY,..the vectors..
K39		I # 'm having a vector of what of
		EIGHT,..newtons..
K40		SIX, newtons
K41		now they # ACT in the SAME direction,..
K42		same direction,
K43		and the ANGLE between them # is what? is?
K44	Ls	<u>zero</u>
K45		[a number of learners talk at the same time]
K46	T	<u>ZERO</u>
K47		now,.. when they # ACT on the SAME..>in the SAME direction<...
K48		we # said
K49		we # can..GET the <RESULTANT> ..
K50		we # can GET the <RESULTANT> of of these two vectors.. in tw-
		two ways
K51		now there # are TWO ways in which we can get the resultant ..
K52		> now the FIRST one please<...
K53		°the first one°...
K54		HOW # can we get the resultant?..

Secondly, in *Stage I* [K47-K54], the classifying taxonomy for methods for solving problems on vector addition, realized through the regulative register, is introduced: Mr. Maletto states ‘**now there are two ways in which we can get the resultant**’ [K51] (*Figure 4.3.1-II* below).

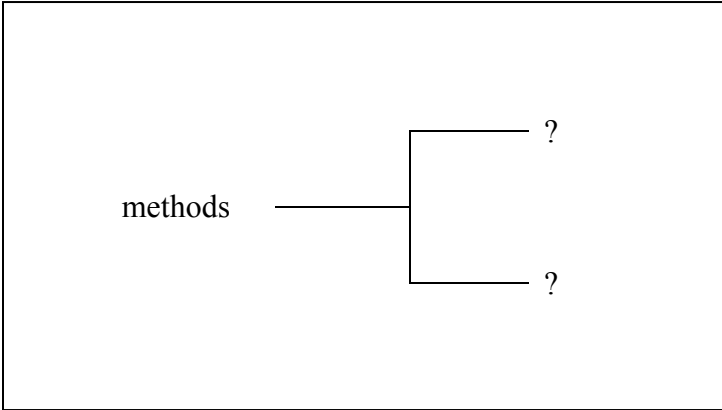


Figure 4.3.1-II Classifying taxonomy (represented by a system network) for the methods for solving problems of vector addition introduced in *Stage II*

The regulative and instructional register in Triadic Dialogue 1B involves a ‘moral regulation’ of the learners’ behaviour. In the ‘moral regulation’ of the learners’ behaviour a ‘pedagogic subject position’ is constructed in the pedagogic discourse. The ‘pedagogic subject position’ constructed in Triadic Dialogue 1B is a learner who is able to use the two methods to solve a problem on vector addition.

In other words, the ‘pedagogic subject position’ is a learner who possesses the ‘recognition’ and ‘realization rules’²⁴ to produce the ‘legitimate text’²⁵, i.e. where the ‘legitimate text’ for Triadic Dialogue 1B is the two methods for solving a problem on vector addition.

Mr. Maleto equips the learners in Triadic Dialogue 1B to be able to produce the ‘legitimate text’ when he makes the evaluation criteria for text production explicit in *Stages I – VII*.

In Lessons A – I, Mr. Maleto and Mrs. McKenzie are also explicit about the evaluation criteria for text production. For example, in Lesson B Mr. Maleto states ‘that’s why I wrote that down there you know two kilometers and for the person who wants to give you marks he sees everything how you got it’ [7.102B-7.104B] [also 9.3E-9.4E]. And in Lesson F Mrs. McKenzie states ‘I’ll give you a few minutes to do that when you’ve done that then I’ll go through just to check that all of us have got the correct answers’ [5.9F-5.11F] [also 2.28G-2.29G].

²⁴ The term ‘recognition’ and ‘realization rules’ is used because the learners need to recognize the context of ‘method 1’ or ‘method 2’ (i.e. possess ‘recognition rules’) before they can choose the appropriate method, namely ‘by calculation’ or ‘by drawing’ (i.e. possess ‘realization rules’). In Lesson B [7.85B-7.91B] and Lesson D [8.12D-8.21D] the learners do not demonstrate possession of both ‘recognition’ and ‘realization rules’ and therefore do not produce the ‘legitimate text’ when solving a problem on vector addition.

²⁵ The term ‘legitimate text’ is used because the learners need to integrate verbal, mathematical and visual literacies to solve a problem on vector addition. In other words, the learners are inducted into verbal, visual and mathematical literacies to solve a problem on vector addition.

The importance of making a text legitimized by the school and society visible to the learner, and in particular to the socially disadvantaged learner, is recognized. In their studies Morais and Neves (2001) found that learners are aided in acquiring both ‘recognition’ and ‘realization rules’ when the specificity of the context and what needs to be added to the learners’ textual production for it to be correct in both transmission and evaluation contexts is made clear to the learners.

In Triadic Dialogue 1B, the ‘pedagogic subject position’, namely a learner who is able to integrate multiple literacies quickly and fluently in real time, is also constructed in the pedagogic discourse (Lemke, 2000).

The ‘pedagogic subject position’ is constructed when Mr. Maletto integrates multiple literacies to solve a problem on vector addition using the two methods.

Firstly, when Mr. Maletto uses ‘multimodal’ literacies to communicate, he makes use of exophoric reference to talk about the different semiotic resources. For example, in *Stage I* Mr. Maletto states ‘**now I think I made something like this**’ [K35-K36] to refer to Chalkboard (1) as shown in *Figure 4.3.1-III* below. In Triadic Dialogue 1B Mr. Maletto also uses exophoric reference [also K90; K109; K110; K112; K120; K200 and K201] and refers to location in space [K90; K106; K107 and K108] as he points to the written, visual and mathematical literacies on the chalkboard.

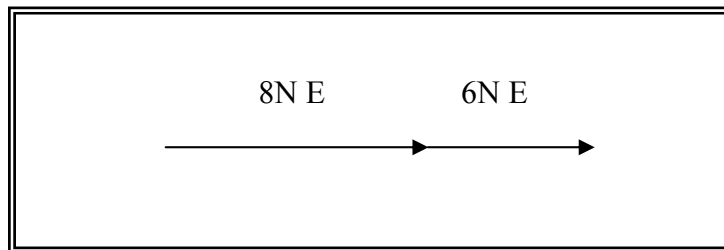


Figure 4.3.1-III Chalkboard (1)

Secondly, when Mr. Maleto uses ‘multimodal’ literacies to communicate, he models the construction of the drawings on the chalkboard. To construct the drawings on the chalkboard Mr. Maleto works neatly and precisely using his ruler, compass and protractor.

Lemke states (n.d.a:4) that “no human activity is affectless”. It is evident that Mr. Maleto loads positive affect onto the meaning-making practice. The end product is a drawing that is aesthetically pleasing as illustrated in *Figure 4.3.2-VI*.

In Lesson D, Mr. Maleto refers explicitly to the importance of aesthetics when constructing a drawing in science. He states ‘I’ve shown you how to draw to make measurements with your pair of compasses; your pencils must be sharp.’ [punctuation added] [4.4D-4.5D]. When Mr. Maleto was heard saying ‘your pencils must be sharp’ in Lesson D a number of learners were observed to get up from their desks to sharpen their pencils at the wastepaper basket in the classroom.

It is thus evident that aesthetics play an important role in the regulation of the learners’ behaviour and in shaping the ‘pedagogic subject position’.

4.3.2 STAGE II

K55	T	>oh by the way WHAT # is the resultant<?...
-----	---	---

In *Stage II* Mr. Maleto explicitly foregrounds verbal language. Mr. Maleto uses the resource of internal addition to add a ‘sidetrack’ to the flow of discourse for Triadic Dialogue 1B; he states ‘**oh by the way** what is the resultant?’ [K55].

K56	T	if I # think of that you know the word <RESULTANT> of a vector
K57		> what # do we mean by that? <..
K58		the <RESULTANT> of a vector...
K59		> what # do we mean by that? <...
K60		[code-switches] [2.3b you do not want to look]
K61		the <RESULTANT of vec>
K62		[code-switches]
K63		I # 'm telling you
K64		yes?
K65	L	it # is an ANSWER of a vector
K66	T	[code-switches] [what is it?]
K67	L	it # is an ANSWER of a vector
K68	T	it # is an ANSWER of a vector?...
K69		what what # do you mean by that?...
K70	T	yes?
K71	L₂	a vector is
K72	T	a RESULTANT,..RESULTANT,
K73	L₂	it # is a vector sum
K74	T	it # is a VECTOR SUM..
K75		yes?
K76	L₂	that are all taken away

The key lexical item ‘the resultant’ [K55] is therefore taught in *Stage II*. In *Stage III*, the key lexical items ‘the magnitude’ [3.11B] and the ‘total resultant vector’ [3.13B] are also taught. The ‘pedagogic subject position’ constructed in the pedagogic discourse is thus a learner who is able to integrate verbal language with the multiple literacies in *Stage II* and *III*.

When Mr. Maleto teaches verbal language explicitly he uses a metalanguage to talk about this language. For example, Mr. Maleto states ‘**if I think of that you know** the word resultant of a vector’ [K56]. Mr. Maleto also uses a metalanguage as a textual resource to ‘manage’ the language of science in Lessons A – I [5.18A; 12.17A; 13.33A; 13.88A; 16.81A; 2.1B; 8.1B; 10.14B; 9.58E; 12.16E; 12.71E; 4.72H; 4.75H; 8.20H].

In *Stage II* the ‘pedagogic subject position’, namely a learner who is able to think and reason using verbal language, is also constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed when Mr. Maleto uses the mental process ‘**think**’ [K56] and the mental process ‘**mean**’ [K59] in ‘**if I think of that you know** the word resultant of a vector **what do we mean by that?**’ [K56-K57] [also K69, K155 and K157] [also 8.1B-8.2B; 12.72E-12.73E and 12.111E-12.112E] to provoke talk. Gee (1996:28) states:

For Plato true knowledge comes about when one person makes a statement and another asks ‘What do you mean?’ [emphasis mine] Such a request forces speakers to ‘re-say’, say in different words, what they mean. In the process they come to see more deeply what they mean, and to respond to the perspective of another voice or viewpoint.

When Mr. Maleto asks ‘**what do we/ you mean by that?**’ [K56, K59 and K69] a learner answers ‘it [the resultant] is an answer of a vector’ [K65] (*Figure 4.3.2-I*) in the move Learner Response. In addition, another learner responds ‘it is a vector sum’ [K73] and then upon being prompted by Mr. Maleto in the move Teacher Follow-up ‘that are all taken away’ [K76] (*Figure 4.3.2-II*).

it	is	an	answer	of	a	vector
Token	Pr: intensive	Value				

Figure 4.3.2-I Analysis of Transitivity for K65

it	is	a	vector	sum
Token	Pr: intensive	Value		

that	are	all	taken	away

Figure 4.3.2-II Analysis of Transitivity for K73 and K76

K77	T	<the RESULTANT # IS the VECTOR SUM of ALL vectors ACTING together>
K78		say # THAT all of us
K79	Ls	<the resultant # is the vector sum of all vectors acting together>
K80	T	the RESULTANT...<ALL vectors ACT taken together>

K81		°and thereafter I # said again you can also put it this way°
K82		the RESULTANT..the RESULTANT.. # IS a SINGLE vector..
K83		it # is a SINGLE vector..which has the SAME..EFFECT..as <ALL
K84	Ls	vectors taken? <u>together</u> > <u>together</u>

However, as the learners' responses do not resemble the 'legitimate text' i.e. the definition provided in the textbook, the learners are 'repositioned'. The 'pedagogic subject position' constructed in the pedagogic discourse in *Stage II* [K77-K84] is a learner who is able to provide the 'textbook' definition for a scientific term.

Firstly, the 'pedagogic subject position' is constructed when Mr. Maleto and the learners recite the definition 'the resultant is the vector sum of all vectors acting together' [K79-K80] when Mr. Maleto states '[the definition] **say that all of us**' [K77-K78] (*Figure 4.3.2-III*). In addition, another definition for 'the resultant' provided by Mr. Maleto in *Stage II* is 'it is a single vector which has the same effect as all vectors taken together' [K83] (*Figure 4.3.2-IV*).

the	resultant	is	the	vector	sum
Token		Pr: intensive	Value		

[of	all	vectors	[[acting	together]]]

Figure 4.3.2-III Analysis of Transitivity for K77

it	is	a	single	vector
Token	Pr: intensive	Value		

[[which	has	the	same	effect	as	all	vectors

[[taken	together]]]

Figure 4.3.2-IV Analysis of Transitivity for K83

Secondly, the ‘pedagogic subject position’ is constructed when Mr. Maletto uses the verbal process ‘say’ [K78] and ‘put it’ [K81] instead of the mental process ‘think’ [K56] or ‘mean’ [K59 and K69]. As a result, what the learners ‘say’ takes precedence over what the learners ‘think’ in *Stage II* [K77-K84].

Lastly, it is evident from the average number of lexical items, i.e. content words, for the definitions [K77] and [K83] that the verbal language the learners are inducted into is removed from the ‘here-and-now’. The average number of lexical items for the definitions [K77] and [K83] are ~seven and ~eight lexical items, respectively (*Figure 4.3.2-V*). The average number of lexical items per clause for non-specialist spoken language is two.

‘the resultant is the vector sum of all vectors acting together’ (no. of lexical words: ~7)

‘it is a single vector which has the same effect as all vectors taken together’ (no. of lexical words: ~8)

Figure 4.3.2-V The Number of Lexical Words for K77 and K83

K85	T	for an example,..
K86		we # said..remember,..
K87		we # said
K88		you # can have a VECTOR..of what, of,..let’s say EIGHT newtons..EAST
K89		that # ’s a vector of EIGHT newtons EAST..followed by another, a vector of what of, of, of, of let, let’s say uhm, uh, again, what let’s say SIX newtons, EAST
K90		right so these # are TWO vectors acting here..
K91		BUT instead of having TWO vectors...ACTING one after the other
K92		you # can have ONE vector..>which would be equal to what<?...
K93		yes?
K94	L	which would be equal to fourteen newtons
K95	T	which would be equal to FOURTEEN newtons?..
K96		is that # all?..
K97	L	east

K98	T	>EAST<
K99		because remember.. #
K100		when you # speak of a vector..
K101		you # CAN'T just say fourteen newtons..
K102		you # must tell me the?
K103	L	direction
K104	T	direction..
K105	T	if the answer # is rea-
K106		okay, okay , so, so, HERE.. # we can have,..ONE single vector..
K107		we # can now have here,..ONE single vector ..
K108		we # can now have here ONE,..single vector of fourteen newtons east..
K109		so THIS # is then the resultant..
K110		it # is the resultant of what? of? THIS vector and THIS vector..
K111		>they # form the resultant<..
K112		this vector # form ONE vector

Finally, towards the end of *Stage II*, the ‘pedagogic subject position’, namely a learner who is able to integrate verbal language with the multiple literacies, is constructed in the pedagogic discourse as well.

Firstly, the ‘pedagogic subject position’ is constructed when the semiotic representations for ‘the resultant’ (namely, verbal – ‘a vector’, ‘the resultant’ and ‘direction’; visual – \longrightarrow ; numbers – ‘14’ and symbols – ‘N’ and ‘E’) are taught as the drawing on the chalkboard expands (*Figure 4.3.2-VI*). In *Stage II* the learners need to do work to construct equivalences one by one, and pair by pair, to make the semiotic representations for ‘the resultant’ equivalent to one another. (Lemke, n.d.b).

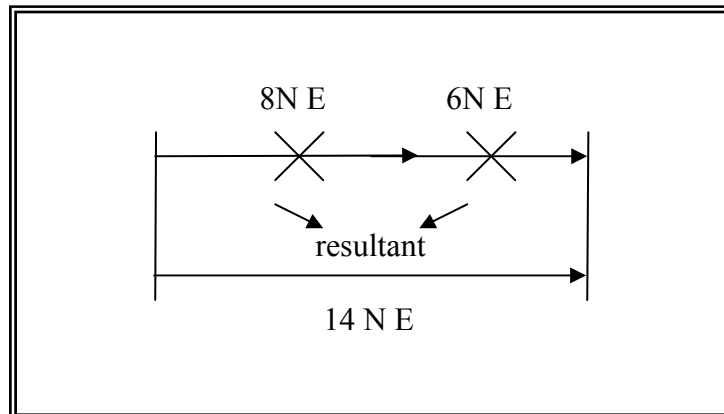


Figure 4.3.2-VI Chalkboard (2b)

Secondly, the ‘pedagogic subject position’ is constructed when Mr. Maletto uses the behavioural processes ‘**speak**’ [K100] and ‘**tell**’ [K102], as well as the resource of negation and modality, to construct acceptable ways of ‘talking’ science. Mr. Maletto states ‘**you can’t just say** fourteen newtons’ [K101] using the negative finite verbal operator ‘**can’t**’ to express a high degree of negativeness; and ‘**you must tell me** the...direction’ [K102-K104] using the finite verbal operator ‘**must**’ to express a high degree of obligation or necessity on behalf of the learners to include direction in their answer.

4.3.3 STAGE III²⁶

		<p>ACTIVITY TYPE: ‘interruption’ [1] [interruption/ language] – ‘magnitude’/ ‘total resultant vector’ FIELD [2]: Magnitude and total resultant vector</p>
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²⁶ Stage III is an Interruption (Lemke, 1993) in which Mr. Maletto addresses language explicitly. As explained in Section 3.5 stages, such as Stage III, have not been analyzed in depth when the length of the Triadic Dialogue is in excess of ~200 clauses so that the analysis of the text by SFL is manageable.

4.3.4 STAGE IV

K113 **T** **NOW..we # said**
K114 **okay NOW if [unclear]**
K115 **now we # STOPPED here..**
K116 **we # said**
K117 **that you # can ADD** vectors acting in the same direction
K118 so we # have..SAME,..direction,..
K119 **and we # said here**
K120 this # is the same as what? as?
K121 ANGLE,..between,..vectors, # is what? equals zero..
K122 **right?..**
K123 zero degrees
K124 **okay?**
K125 >the angle between the vectors # is now equal to zero degrees<

In *Stage IV* the drawing on the chalkboard expands as Mr. Maleto writes ‘same direction’ and ‘angle between vectors = 0°’ on the chalkboard, as shown in *Figure 4.3.4-I* below.

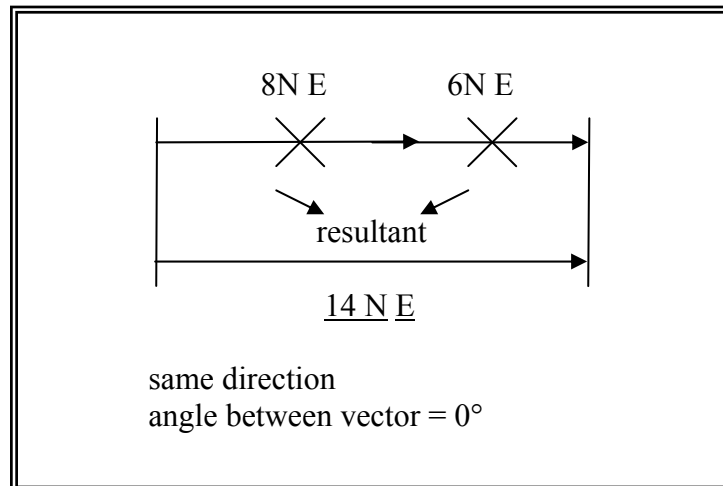


Figure 4.3.4-I Chalkboard (6)

The Revised National Curriculum Statement Grades R – 9 (South Africa, 2002) and Grades 10 – 12 (South Africa, 2003c) emphasize the importance of teaching

‘multimodal’ literacies. The Revised National Curriculum Statement Grades 10 – 12 (South Africa, 2003c:38) states that the description of motion in words, diagrams, graphs and equations is a core concept for ‘Learning Outcome 2: Constructing and Applying Scientific Knowledge’ under the theme ‘motion in one dimension’.

Mr. Maleto teaches multiple literacies in Triadic Dialogue 1B implicitly and explicitly.

Firstly, when Mr. Maleto teaches multiple literacies implicitly, he repeats information, i.e. there is redundancy. For example, the part-whole taxonomy, as shown in *Figure 4.3.4-II* below, is built for the word ‘vector’ as the word ‘vector’ is used in the context of *Stage I to Stage IV* [K15; K21; K31; K77; K84; K92-K98; K117 and K121]. In Lesson E, Mr. Maleto represents the part-whole taxonomy on the chalkboard, as shown in *Figure 4.3.4-III* below. Lemke (1995) states that redundancy is always necessary in semiotics for the construction of meaning, as events (including spoken or written words) do not have intrinsic meanings but only the meanings we make for them by fitting them into various contexts, i.e. a meaning potential.

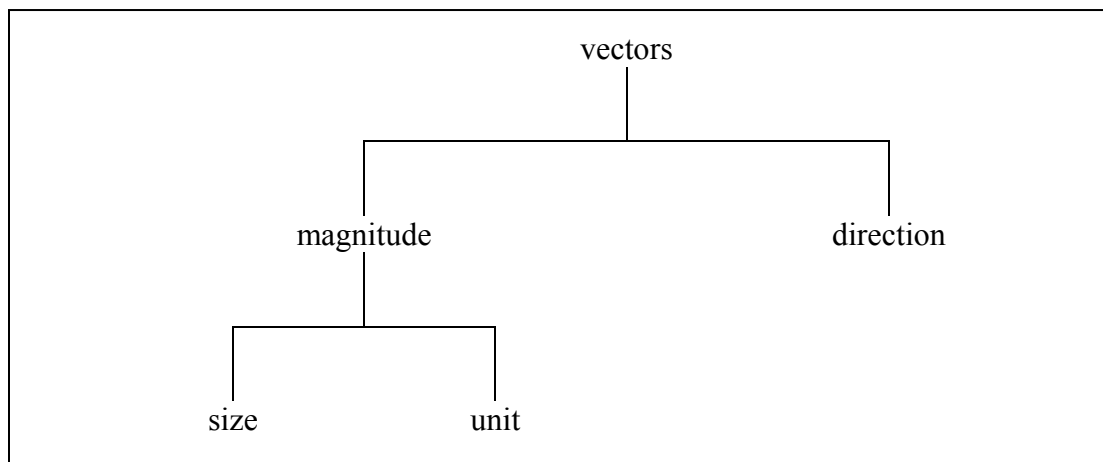


Figure 4.3.4-II The part-whole taxonomy (represented by a tree diagram) for vectors created in *Stage I – Stage IV*

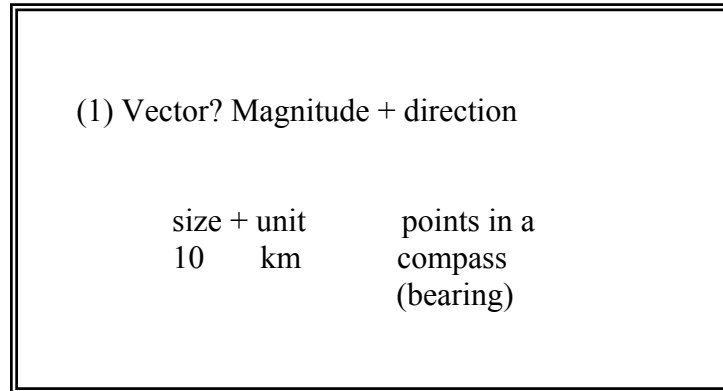


Figure 4.3.4-III Chalkboard (10); Lesson E

However, Lemke (1998) states that the various semiotic representations for a concept, such as ‘a vector’, are not redundant. Instead Lemke (1998) states it is by the joint co-deployment of two or more semiotic modalities that meanings are made in the science classroom and that such co-deployment of resources is needed for the interpretation of scientific texts.

Secondly, when Mr. Maleto teaches multiple literacies explicitly, he gives explicit instruction in being able to move back and forth between the different verbal, visual and mathematical literacies (Lemke, n.d.b). For example, in Lesson A [16.75A-16.80A] Mr. Maleto states:

- T** speed mathematically speed equals distance over time but let’s talk it now [emphasis mine] this means speed is the rate of distance over velocity displacement time say it in words now [emphasis mine] [repetitions omitted]
- Ls** velocity is the rate of displacement
- T** that’s all don’t make things difficult for yourself

To conclude, when Mr. Maleto teaches multiple literacies implicitly and explicitly the ‘pedagogic subject position’, namely a learner who is able to integrate multiple literacies quickly and fluently in real time, is constructed in the pedagogic discourse.

4.3.5 STAGE V²⁷

		ACTIVITY TYPE: ‘review’ [1]; ‘groupwork’ [1] [groupwork/ preparation for groupwork] FIELD [2]: Problem 1
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In *Stage V* the ‘pedagogic subject position’, namely a learner who plays a more active role in ‘problem solving’ in the science classroom, is initially constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed when Mr. Maleto invites the learners to solve the problem on vector addition in their groups. To “work effectively with others as members of a team, group, organization and community” is one of the seven Critical Outcomes that underpin the Learning Outcomes for the National Curriculum Statement Grades 10 – 12 (South Africa, 2003c:2).

However, towards the end of *Stage V*, the learners are repositioned. The groupwork is abandoned due to time constraints and instead the problem is solved in *Stage VI* and *VII* of Triadic Dialogue 1B. The ‘pedagogic subject position’ constructed in the pedagogic discourse thus becomes a learner who takes a more passive role in ‘problem solving’ in the science classroom.

4.3.6 STAGE VI

K126	T	okay FINE..so..we # look at WHAT? at the displacement
K127		now,..and then we # said
K128		there # are TWO ways in which we can get the [K129 omitted]

²⁷ *Stage V* is Groupwork (Lemke, 1993) in which Mr. Maleto and the learners attempt to engage in a groupwork session. As explained in Section 3.5 stages, such as *Stage V*, have not been analyzed in depth when the length of the Triadic Dialogue is in excess of ~200 clauses so that the analysis of the text by SFL is manageable.

		resultant ..
K130		>give # me two ways in which one can get the resultant of those two vectors<..
K131		uh?..
K132		we # KNOW this,..
K133		we # 've DISCUSSED this,..
K134		BUT give # me TWO ways..in which the resultant of what? of EIGHT newtons, EAST AND SIX newtons, EAST can be found..
K135		>and the FIRST method ,< ...
K136		>the FIRST method ,<..
K137		[code-switches] [what is it?]
K138		YES [name]?
K139	L	we # can get it by calculation
K140	T	we # can get it by calculation,
K141		yes,..we # can get it by calculation, ..
K142		SIMPLE calculation,..

In *Stage VI* Mr. Maleto explicitly foregrounds mathematics when the learners are taught the first method for solving problems on vector addition, namely ‘by calculation’ (*Figure 4.3.6-I*).

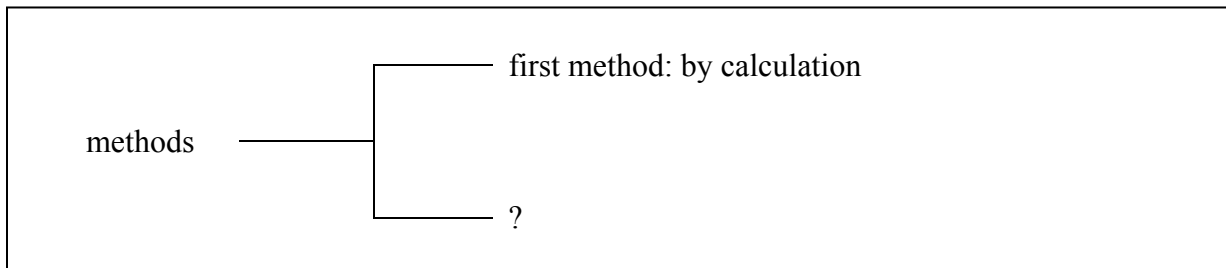


Figure 4.3.6-I The classifying taxonomy (represented by a system network) for methods for solving problems on vector addition built in *Stage VI*

The ‘pedagogic subject position’, namely a learner who is able to integrate mathematics with the multiple literacies in *Stage VI*, is constructed in the pedagogic discourse.

Firstly, the ‘pedagogic subject position’ is constructed when Mr. Maletto integrates mathematics²⁸ with the verbal and visual literacies constructed in *Stage I - Stage VI* to solve the problem on vector addition. In Lesson C [4.13C-4.14C] Mr. Maletto explicitly refers to the integration of multiple literacies when solving a problem on vector addition by calculation; he states ‘Now, in science, remember, whenever you are going to do a calculation in science, you’ve got to draw a little sketch.’ [also 11.16I-11.18I] [punctuation added].

When Mr. Maletto and the learners solve the problem on vector addition in *Stage VI* Mr. Maletto writes the calculation on the chalkboard as shown in *Figure 4.3.6-II* below.

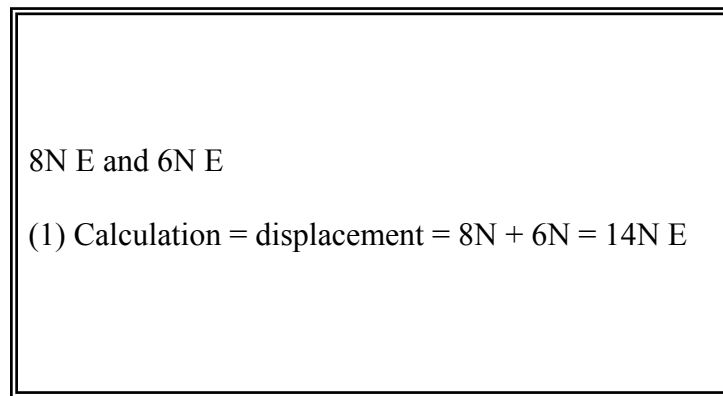


Figure 4.3.6-II Chalkboard (8)

In addition, when Mr. Maletto teaches mathematics explicitly he uses a metalanguage to talk about this language. For example, Mr. Maletto states ‘**we can get it by calculation**’ [K140]. In Lessons A – E, the learners appear to be aided in acquiring both the ‘recognition’ and ‘realization rules’ to produce the ‘legitimate text’ when Mr. Maletto uses the formulaic expression ‘by calculation’ [K140]. In other words, the formulaic expression ‘by calculation’ aids the learners to recognize the ‘micro-context of problem solving’ (Morais and Neves, 2001), namely the first method, and to know how to proceed to solve the problem, namely ‘by calculation’.

²⁸ Lemke (n.d.a:2-3) states that mathematics is not identified by the use of specialized mathematical symbolism, but by the kinds of meanings it makes, meanings such as addition, subtraction, multiplication, division and many more that have evolved in the history of mathematics.

K143	T	we # can get it by <calculation> yes,..which is here VERY EASY,..
K144		because of the same thing >you know direction<
K145		SO it # will be?..
K146		you know the displacement # will be?..
K147		the displacement # WOULD be equal to what? EIGHT newtons,..plus WHAT? plus? SIX newtons,
K148		and this # will be FOURTEEN newtons, EAST
K149		that # 's by calculation..

Secondly, the ‘pedagogic subject position’ is constructed when Mr. Maletto states categorically ‘this is how we do things in mathematics’. In Lessons A – I, Mr. Maletto often makes reference to ‘this is how we do things in mathematics’. For example, in Lesson C, Mr. Maletto states ‘Now, in mathematics, if you have got two over x equals two over x it is as much as writing the same thing here, as what? Which is the simplest way of writing this thing?’ [4.120C-4.122C][punctuation added][also 16.24A; 16.51A; 16.54A; 16.68A-16.69A; 16.75A-16.76A; 3.17C; 3.55C; 3.55C-3.56C; 4.89A; 4.120C-4.122C; 9.7C-9.8C; 11.10D-11.11D; 13.67D-13.68D; 4.29E-4.41E; 15.1E-15.8E]. As discussed in 2.1.6 the integration within and across subjects and fields of learning is emphasized in the Revised National Curriculum Statement Grades 10 – 12 (South Africa, 2003c:3).

Finally, in *Stage VI*, the ‘pedagogic subject position’, namely a learner who remembers to include ‘units’ when solving a problem on vector addition, is constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed in *Stage VI* when Mr. Maletto states ‘The displacement would be equal to, what? Eight newtons plus, what? Plus six newtons, and this will be fourteen newtons east.’ [K147-K148] [punctuation added].

In Lesson B, the ‘pedagogic subject position’ is also constructed when Mr. Maletto explicitly draws the learners’ attention to the unit ‘the newton’ in ‘14N’ and ‘14N E’; he states:

I told you in science we hate naked numbers... You can't speak of, what? Two, three, nine, seven. It's seven kilograms or ten newtons... You can't just give, what? A number. Okay, are you happy? [3.14B-3.19B] [punctuation added]

In addition, in Lessons A – I, the 'pedagogic subject position' is constructed when Mr. Maleto and Mrs. McKenzie reiterate the importance of 'units'. For example, in Lesson A, Mr. Maleto states:

We speak of meters per second because we want to use standard international units, meter and second, right? So, we can't have kilometers per hour, k p h, or simply kilometers per hour. [13.28A-13.30A] [punctuation added]

And in Lesson F Mrs. McKenzie states 'you must have those k gs on your answers' [6.13F].

Lastly, in Lesson C [4.68C-4.71C] it is evident that the learners have taken this message to heart and are beginning to 'talk' and 'reason' like their teachers in this regard. Mr. Maleto states:

T is that the answer there yes
L that is not the answer because in science you can't have naked numbers
T you are right so answer is
L thirteen point five kilometers

4.3.7 STAGE VII

K162	T	the FIRST method.. # <<yes I agree>>[is] ..by calculation	[K150-K161 omitted]
K163		we # can get at our displacement by calculating, by ADDING, by calculating...	
K164		°yes [name]°?	
K165		°the answer # is°?	
K166	L	by measurement	
K167	T	by MEASUREMENT?..	
K168		yes? by MEASUREMENT and?..	
K169		you # MEASURE something	
K170		and you # do what?...	

K171		you # measure
K172		and?
K173	L	draw
K174	T	and # DRAW
K175		yes, very good..
K176		so we # can get the very SAME, displacement by,..by drawing,..and measurement..and measurement..

In *Stage VII* Mr. Maletto explicitly foregrounds visual representations when the learners are taught the second method for solving problems on vector addition, namely ‘by measurement and drawing’ (*Figure 4.3.7-I*).

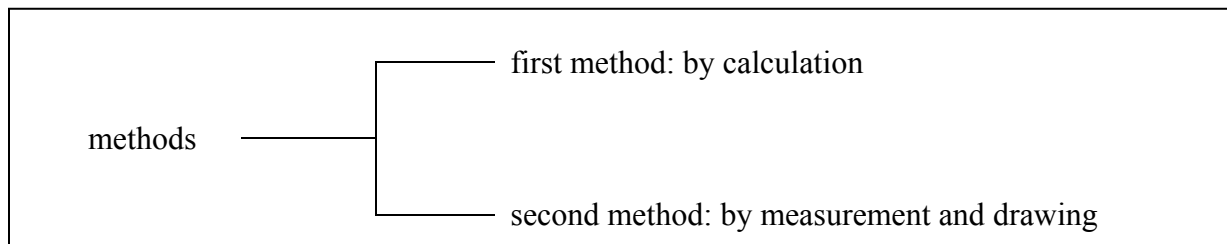


Figure 4.3.7-I The classifying taxonomy (represented by a system network) for methods for solving problems on vector addition built in *Stage VII*

K177	T	now when you # do a measurement
K178		what # must you first find?..
K179		if you # want to make a DRAWING..in SCIENCE
K180		then we # speak of? what? of drawing?
K181		[code-switches] [it's not easy]
K182		yes?
K183	L	scale drawing
K184	T	SCALE drawing..
K185		so we use what? a scale drawing..
K186		I # use scale drawing..SCALE drawing, and what? SCALE drawing, and what? and? measurement
K187		now [unclear]
K188		and measurement
K189	T	remember #
K190		we # did it

K191		we # measured what?
K192		EIGHTY,..millimeters and? right plus what? plus?..SIXTY, millimeters
K193		and the TOTAL # was what? was?
K194	L	one hundred and forty
K195	T	was one hundred and forty, millimeters which was equal to
K196		[code-switches] [what]
K197		to fourteen?
K198	Ls	kilometers
K199	T	kilometers east
K200		and THIS # was equal to, SIX kilometers..east
K201		and THIS # was equal to, EIGHT kilometers..east
K202		that # 's how we did it

The ‘pedagogic subject position’, namely a learner who is able to integrate visual representations with the multiple literacies in *Stage VII*, is constructed in the pedagogic discourse.

Firstly, the ‘pedagogic subject position’ is constructed when Mr. Maletto integrates visual representations with the verbal and mathematical literacies in *Stage VII* to solve the problem on vector addition.

When Mr. Maletto and the learners solve the problem on vector addition Mr. Maletto constructs a ‘scale drawing’ [K183] on the chalkboard as shown in *Figure 4.3.7-II* below.

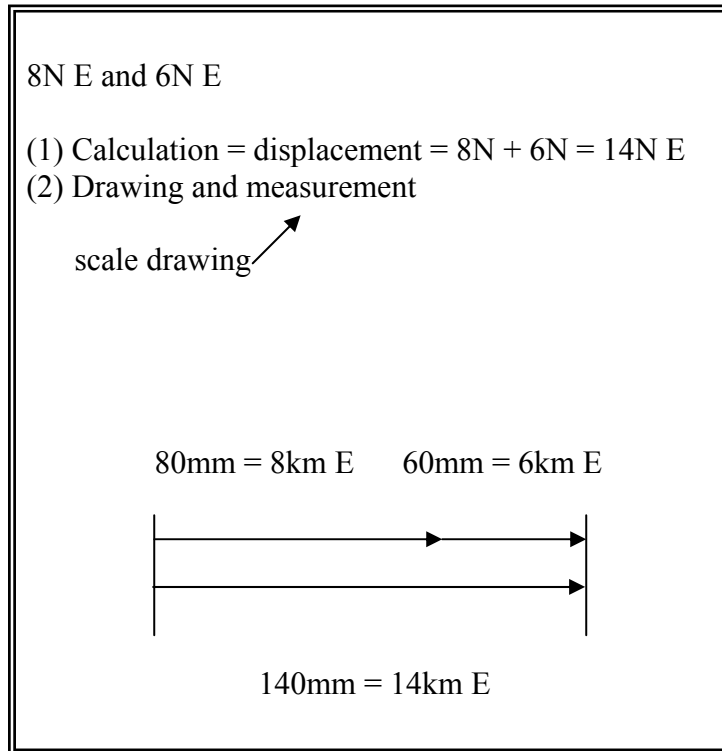


Figure 4.3.7-II Chalkboard (9b) and Chalkboard (10)

To construct the ‘scale drawing’ on the chalkboard the learners are taught to work with ratios. In addition, the learners are taught to manipulate these ratios with fractions²⁹. In Lesson B Mr. Maletto provides the learners with a reason for working with ratios; he states ‘I’ve given you the scale there you must use this because you can’t draw eight kilometers on your exercise book and you can’t draw what six kilometers’[7.16B-7.18B].

Lastly, when Mr. Maletto teaches visual representations explicitly he uses a metalanguage to talk about this language; Mr. Maletto states ‘**we can get** the very same displacement **by drawing and measurement**’ [K176]. In Lessons A – E, the learners appear to be aided once more in acquiring both the ‘recognition’ and ‘realization rules’ to produce the

²⁹ Fractions represent significant differences of potentially arbitrarily small degree (i.e. what is essentially a topological meaning) quasi-linguistically (i.e. with typological sign resources). It is for this reason Lemke states that learners find the representation and manipulation of ratios by fractions confusing. (Lemke, n.d.a:7).

‘legitimate text’ when Mr. Maleto uses the formulaic expression ‘by measurement and drawing’ [K140]. In other words, the formulaic expression ‘by measurement and drawing’ aids the learners to recognize the ‘micro-context of problem solving’ (Morais and Neves, 2001), namely the second method, and to know how to proceed to solve the problem, namely ‘by measurement and drawing’.

In Lesson B [7.85B-7.91B], a learner does not demonstrate possession of the ‘recognition rules’ for the ‘micro-context of problem solving’, namely the second method, and therefore does not show ‘correct performance’ in solving the problem on vector addition.

Mr. Maleto states:

- T** how did I find my two kilometers yes
L you minused sir
T you see I didn’t do any calculation here you see now I said there are two methods I’m still dra- you know dra- doing the measurement and drawing yes how did I yes
L you measure it sir
T you measure that line you measure this line

Secondly, the ‘pedagogic subject position’ is constructed in the pedagogic discourse when Mr. Maleto states categorically ‘this is how we do things in science’. For example, in *Stage VII*, a learner responds ‘scale drawing’ [K183] when Mr. Maleto asks ‘**if you want to make a drawing in science then we speak of what of drawing?**’ [K179].

In Lessons A – I, Mr. Maleto also refers to ‘this is how we do things in science.’ For example, in Lesson E, Mr. Maleto says ‘We always measure clockwise in science to get the direction.’ [12.39E] [punctuation added] and in Lesson A, ‘I’ve said in science we like to economize with the writing. It means we like to write in a short way, an easy short way.’ [5.27A-5.28A] [punctuation added] [also 3.14B-3.19B and 4.13C-4.15C].

Finally, in *Stage VII*, the ‘pedagogic subject position’, namely a learner who is able to use ‘symbols’ when he/ she communicates in the science classroom, is constructed in the pedagogic discourse.

The ‘pedagogic subject position’ is constructed when Mr. Maleto writes the symbol ‘N’, which denotes ‘the newton’, and ‘E’, which denotes ‘east’, on the chalkboard. However, in Lessons A – I, the symbol ‘N’ also denotes ‘north’ and the symbol ‘E’ denotes ‘energy’. In *Stage I – VII*, the learners learn to connect these symbols with the context in which they are used (Lemke, n.d.b).

In Lessons A – I the learners are also taught ‘symbols’ as a semiotic resource (Lemke, n.d.a). In addition, when Mr. Maleto and Mrs. McKenzie teach ‘symbols’ explicitly they use a metalanguage to talk about this semiotic resource. In Lesson C [3.49C-3.52C] [also 3.52C-3.55C] Mr. Maleto states:

T who remembers a symbol here yes
L x squared
T x squared

And in Lesson F [4.26F-4.29F] [also 1.1F] Mrs. McKenzie states:

T what’s acceleration due to gravity it’s not an a it’s got a special letter because it’s used so much yes
L small g
T small g

Lastly, it is evident from Lesson A that Mr. Maleto makes decisions about the appropriate time to teach certain of the semiotic resources, such as ‘symbols’, employed in the science classroom. In Lesson A, Mr. Maleto states ‘I’ve said in science we like to economize with the writing. It means we like to write in a short way, an easy short way. I haven’t shown you that, right? But before I do that...’ [5.27A-5.29A] [repetitions omitted] [punctuation added] when he refers to the equation for ‘velocity’. The grade 10 learners were not taught the symbols for ‘displacement’, ‘velocity’ and ‘acceleration’ in the unit ‘mechanics’. In comparison, it is evident from the grade 11’s class notes that the grade 11s use the symbols ‘s’, ‘v’ and ‘a’ to denote ‘displacement’, ‘velocity’ and ‘acceleration’, respectively, when solving problems to do with vectors.

CONCLUSION

In Triadic Dialogue 1B the instructional and regulative register are intimately associated and the pedagogic discourse involves a ‘moral regulation’ of the learners’ behaviour (in terms of behaviour to do with the induction of the learners into the ‘languages’ science).

The ‘ideal pedagogic subject position’ for Triadic Dialogue 1B is a learner who, when solving a problem in the science classroom, is able to integrate multiple literacies quickly and fluently in real time; use ‘symbols’; and remembers to include the ‘units’.

In other words, the ‘ideal pedagogic subject position’ is a learner who possesses the ‘recognition’ and ‘realization rules’ to produce the ‘legitimate text’, i.e. where the ‘legitimate text’ for Triadic Dialogue 1B is the two methods for solving a problem on vector addition.

The ‘ideal pedagogic subject position’ is constructed in the pedagogic discourse when Mr. Maletto teaches the ‘multimodal’ literacies implicitly and explicitly; states categorically ‘this is how we do things in science and/ or mathematics’; and refers directly and indirectly to the ‘ideal pedagogic subject position’.

When Mr. Maletto teaches multimodal literacies implicitly, Mr. Maletto:

- 1) Integrates multiple literacies (e.g. ‘a little sketch’; ‘a calculation’; ‘a scale drawing’; ‘ratios’; ‘fractions’);
- 2) Makes extensive use of exophoric reference to talk about the different semiotic resources;
- 3) Models working neatly and precisely for the construction of visual literacies;
- 4) Loads positive affect onto the different meaning-making practices in the science classroom;
- 5) And repeats information, i.e. there is redundancy.

When Mr. Maleto teaches multimodal literacies explicitly, he:

- 1) Uses a metalanguage (e.g. ‘a little sketch’; ‘a calculation’; ‘a scale drawing’; ‘symbol’; ‘word’) to talk about the different semiotic resources;
- 2) And gives explicit instruction in being able to move back and forth between the different verbal, mathematical and visual literacies.

In addition, Mr. Maleto equips the learners to be able to produce the ‘legitimate text’ by:

- 1) Making the evaluation criteria for text production explicit;
- 2) Using the formulaic expression ‘by calculation’ and ‘by measurement and drawing’ to aid the learners in acquiring the ‘recognition’ and ‘realization rules’;
- 3) And choosing the appropriate time to introduce certain of the semiotic resources so that the learners have less to process at a given time.

Finally, it has been learnt from Triadic Dialogue 1B that the learners are ‘positioned’ and ‘repositioned’ in the science classroom as learners who play an active role in problem solving to learners who play a more passive role; and as learners who think and reason using verbal language to learners who recite the definition from the textbook.

4.4 LOGOGENESIS FOR THE ACTIVITY TYPE TRIADIC DIALOGUE 4H

In Triadic Dialogue 4H³⁰, *Stages I – VIII*, I report on the ‘logogenesis’ (Christie, 2002 and Martin and Rose, 2003) of the text.

In reporting on the ‘logogenesis’ for *Stages I – VIII* the following is foregrounded:

- 1) The ‘developmental history’(Christie, 2002) for the unit ‘mechanics’ as it is revealed by the ‘logogenesis’ of Triadic Dialogue 4H;
- 2) The new language (and the reasoning encoded in it) modeled and appropriated in Triadic Dialogue 4H;
- 3) And the role of ideology in shaping the ‘developmental path’ of a key lexical item as it is used and reused in different contexts.

A brief summary of the findings is then provided to conclude the section.

4.4.1 STAGE I

M1	T	alright..NOW..what we then did here.. # was to find the RESULTANT
M2	T	NOW..now..°we # then..drew something like that...
M3		we # had something like this°
M4		[code-switches] [is that so?]
M5		in our experiment
M6		[code-switches] [is that so?]
M7	Ls	yes
M8	T	right in our experiment # [unclear] we had something like that^{repetition1} ...
M9		°we # had something like that^{repetition1} ...
M10		we # had something like that°^{repetition1} ..
M11		then..you # made your experiment..
M12		and then you... # you said..
M13		there # ’s a FORCE, this side
M14		[there # is] a FORCE, this side
M15		and [there # is] a force here

³⁰ Transcript 4H is included in Appendix B (pp.118 – 121).

M16		I # 've got one NEWTON,
M17		zero point eight NEWTONS,
M18		zero point seven
M19		the POINT # is acting here
M20		and we # then wanted to find WHAT? the RESULTANT of these two forces
M21	T	and of course it # was quite EASY
M22	T	because you # used WHAT?..you used your PAIR of WHAT? of your your your PAIR of WHAT? of?
M23	Ls	compasses
M24	T	COMPASSES.. to get THAT there,
M25		and of course again HERE, to get it THERE,
M26	T	>I # hope
M27		I # 'll be RIGHT here<,
M28		then we # joined the TWO ^{repetition2} ...
M29		then we # JOINED the two ^{repetition2} ..
M30		>I # 'm lucky..
M31		not very<..
M32		we # JOINED the two ^{repetition2} ,
M33		and we # found out
M34		that...the resultant # is like that
M35		°and then I # asked you a few questions
M36		so THIS # is the resultant of this force
M37		and # this force..
M38		mm?..
M39		this # is the resultant
M40		this line # is the resultant of these forces°

In Triadic Dialogue 4H Mr. Maleto and the grade 11 learners review an experiment on ‘forces in equilibrium’. To review the experiment Mr. Maleto and the learners use multiple literacies and apparatuses, as shown in *Figure 4.4.1-I* and *4.4.1-II*.

In *Stage I*, Mr. Maleto constructs a ‘force diagram’, as shown in *Figure 4.4.1-I* below, on the chalkboard. The ‘force diagram’ is for apparatus (1), as shown in *Figure 4.4.1-II* below, set up during the experiment. Mr. Maleto and the learners set up apparatus (1) and construct the ‘force diagram’ to calculate the ‘resultant force’.

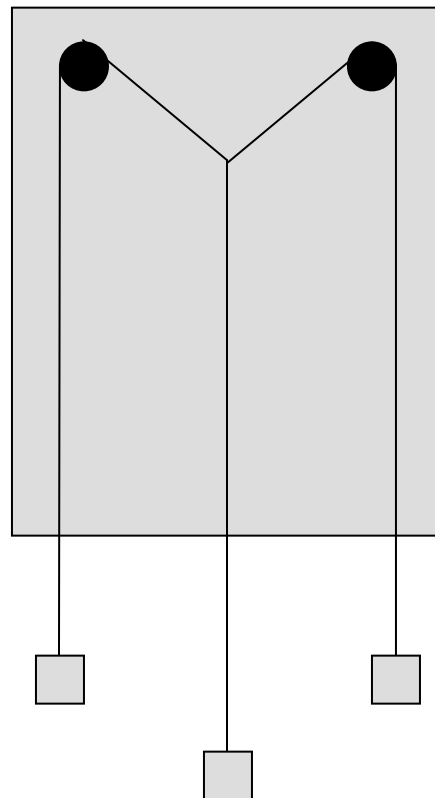
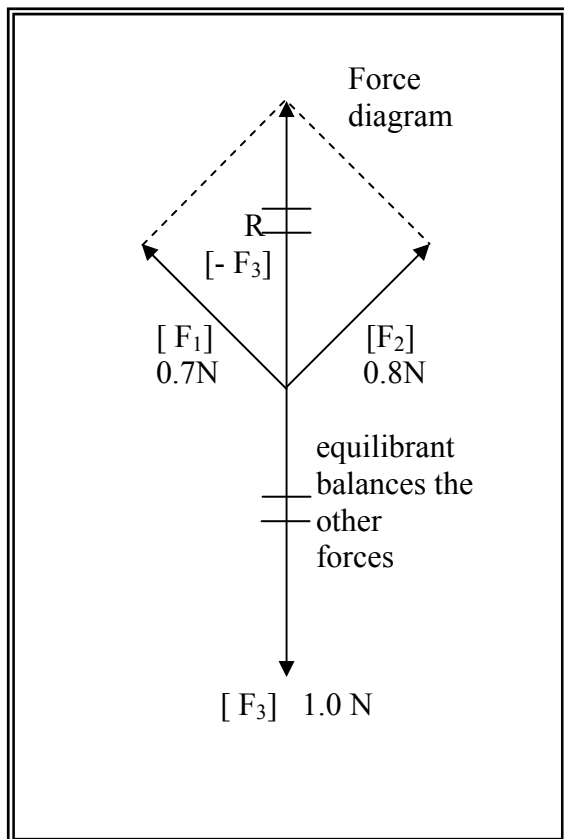


Figure 4.4.1-I Chalkboard (4) – The ‘force diagram’ Figure 4.4.1-II apparatus (1) for Apparatus (1)

When Mr. Maletto and the learners use multiple literacies and apparatus (1) to calculate the ‘resultant force’ a ‘developmental history’ for the unit ‘mechanics’ is revealed. The ‘developmental history’ for the multiple literacies, and in particular the technical language of science, is discussed in this section.

In Triadic Dialogue 4H the following key lexical items have a ‘developmental history’: ‘the resultant’ [M1]; ‘the magnitude’ [M47]; ‘accelerate’ [M60-M62] and ‘at rest’ [M88]. In Triadic Dialogue 4H these key lexical are taught implicitly. In addition, they are used and reused in a different context, namely ‘forces in equilibrium’. In grade 10, however, these key lexical items were taught explicitly. To teach these key lexical items explicitly, Mr. Maletto does the following in Lessons A – E:

Firstly, Mr. Maletto uses multiple literacies to explain a key lexical item.

For example, in Lesson B, Mr. Maletto teaches the difference between the key lexical item ‘the magnitude’ and the ‘total resultant vector’ to the grade 10 learners. In Lesson B [3.11B-3.14B], Mr. Maletto states:

so be very careful when you answer questions you must listen to the question if the question wants magnitude then this is correct but if it wants the total resultant vector you must give the magnitude and direction

To emphasize ‘the magnitude’, namely 14N, Mr. Maletto circles 14N. In addition, to evaluate ‘14N’ as correct Mr. Maletto places two ticks (i.e. ✓✓) above ‘14N’ (Figure 4.4.1-III). Lastly, to emphasize ‘the magnitude and direction’, Mr. Maletto underlines ‘14 N E’ (Figure 4.4.1-IV).

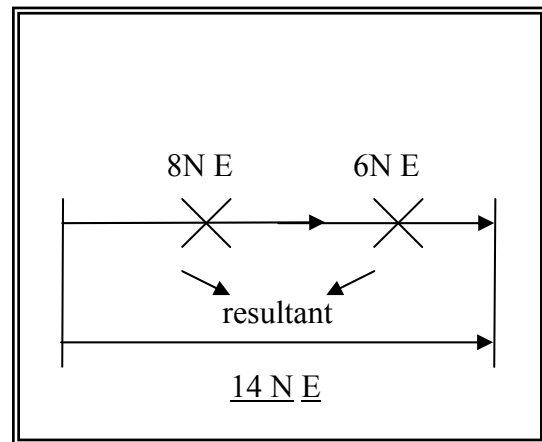
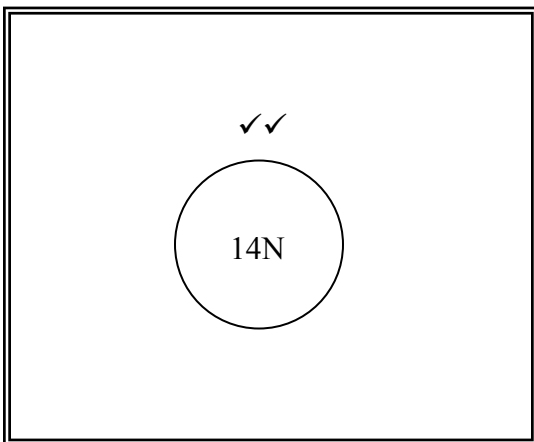


Figure 4.4.1-III Chalkboard (4); Lesson B

Figure 4.4.1-IV Chalkboard (5); Lesson B

Secondly, Mr. Maletto prompts the learners to recite the definition for a key lexical item.

For example, in Lesson B, the grade 10 learners are prompted to recite the definition for ‘the resultant’ together in unison. In Lesson B [2.1B-2.15B] Mr. Maletto states:

T oh by the way what is the resultant if I think of that you know the word resultant of a vector what do we mean by that the resultant of a vector... the resultant is the

Firstly, in Lesson B [10.1B-10.10.3B] Mr. Maletto performs a demonstration to elicit the ‘rule’ from the grade 10 learners. Mr. Maletto takes four large steps in the direction of the learners and then from a different point of departure once again takes another four large steps in the direction of the learners. Whilst performing the demonstration Mr. Maletto elicits the ‘rule’ by stating:

Okay, let’s see. One, two, three, four. I’ve walked four meters from there in this direction. Is this any different from this? I’m now here. I was there. One, two, three, four, in the same direction.

Secondly, in Lesson D [5.1D-5.20D] Mr. Maletto engages in an extended Triadic Dialogue with the grade 10 learners to elicit the rule. Mr. Maletto states:

- T** now there is a certain thing I told you about vectors which includes magnitude and direction what did I say yes...
- L** a vector can be changed to another place
- T** a vector can be changed to another place yes as long as you do what yes
- L₁** [unclear]
- T** as long as yes
- L₁** the magnitude stays the same
- T** the magnitude stays the same and two things
- L₁** the direction
- T** and the direction stays the same

In Lesson H, it is evident that the grade 11 learners have appropriated this ‘rule’. In Lesson H [8.4H-8.5H] Mr. Maletto states:

- T** right now earlier I said something about vectors I said something about take a vector who remembers I said something about direction or position of a vector do you remember [name]
- L** you said yes you can take any vector and put it into the other position as long as you don’t change its direction
- T** very good boy very good

The ‘rule’, ‘You can take any vector and put it into another position as long as you don’t change its direction’, is idiosyncratic to Mr. Maletto and his learners. It can thus be

concluded that the grade 11 learners have gained this language from being members of this particular discourse community; a ‘developmental history’ can thus be traced to a particular discourse community [also 15.25H-15.29H].

Finally, although the key lexical items the ‘resultant’ and ‘force’ have a ‘developmental history’ in Mr. Maleto’s class that can be traced to grade 10, the key lexical item ‘the resultant force’ does not.

This was evident from the lessons observed and the learners’ note books collected in the first and second term. Whereas Mrs. McKenzie chose to teach ‘force diagrams’ in grade 10, Mr. Maleto chose to teach ‘force diagrams’ in grade 11.

As a result, it might be argued that by weakening the classification and framing (as discussed in Triadic Dialogue 8A) the ‘developmental history’ for ‘the resultant force’ is absent in grade 10. In other words, Mr. Maleto’s grade 10 learners tended to remain within ‘the everyday’ in terms of their understanding of force and did not progress towards ‘the scientific’; Mr. Maleto’s grade 10 learners would not have been able to explain why ‘a force does not necessarily make things to move’ in terms of ‘the scientific’ – by drawing a ‘force diagram’, talking explicitly about the ‘resultant force’ or otherwise – from Triadic Dialogue 8A or from the lessons observed and class notes collected for the first two terms of the school year in which the unit mechanics was taught.

4.4.2 STAGE II

M41	T	now..IF THIS..sorry..
M42		if this.. # is the resul-
M43		if this line..the DIAGONAL of this..RECTANGLE.. # is the RESULTANT of these two forces
M44		what # do you find?
M45		you # actually found
M46		that?

M47		its magnitude # is equal to what? repetition3 ...
M48		°its magnitude # is equal to what?° repetition3 ..
M49		yes boy?
M50	L	to the one newton force acting downwards
M51	T	to the one newton force acting DOWNWARDS
M52		we # found
M53		that it # is almost EQUAL here
M54		> we # found out
M55		that this force here # is also that force there<
M56		so the RESULTANT of these two forces..< # is one newton>

As the text unfolds in Triadic Dialogue 4H key lexical items are used and reused in different contexts, i.e. there is ‘redundancy’ (Lemke, 1995). As these key lexical items are used and reused in different contexts, ideology can come into play (Bernstein, 2000). As a result the ‘developmental path’³¹ for a key lexical item can take on a particular form depending on how ideology has come into play.

For example, in *Stage II* and *VIII* the ideology of the authoritative nature of science comes into play and the definition for the ‘equilibrant’ is transformed into two ‘conditions’ (referred to as a ‘condition’ in *Stage VIII* [M174-M175]).

In *Stage II*, the first ‘condition’ for the ‘equilibrant’ is introduced, namely ‘the resultant’s magnitude is equal to the one newton force (i.e. the equilibrant) acting downwards’ (*Figure 4.4.2-1* below).

³¹ Christie (2002) uses the term ‘developmental history’ to describe the developmental progress in the language use that takes place over time as the teacher and learners engage seriously with uncommonsense knowledge. The term ‘history’ can be defined as ‘the study of past events’ (Oxford English Dictionary). In *Stage I*, the ‘history’ of the key lexical items ‘the resultant’, ‘the magnitude’, ‘to accelerate’ and ‘at rest’ is traced, i.e. the ‘event’ in grade 10 when the key lexical is taught explicitly is identified. As the term ‘history’ is to do with events, the meaning embodied in the term can be described as ‘typological’ (Lemke, 1998). As it is evident in *Stage II* that language can be transformed in the science classroom as ideology comes into play, i.e. as it is used and reused in different context, I have used the term ‘developmental path’ in conjunction with the term ‘developmental history’. The meaning embodied in the term ‘developmental path’ can be described as ‘topological’ (Lemke, 1998). The path taken by the key lexical items can therefore be described to take on different forms depending on how ideology has come into play.

its [the resultant's]	magnitude
Token	

is	equal	to	the	one	newton	force
Pr: intensive			Value			

[[acting	downwards]]

Figure 4.4.2-I Analysis of Transitivity for M48-M50

In comparison, the definition provided in the textbook is “The **equilibrant** of any number of forces is the single force needed to produce equilibrium. It has the same magnitude as the resultant [emphasis mine], but acts in the opposite direction.”

It can thus be said that in the ‘delocation’, ‘relocation’ and ‘transmission’ of the definition for the ‘equilibrant’ a space has been created in which ideology can play and the definition for the ‘equilibrant’ has been transformed to two ‘conditions’ (Bernstein, 2000 and Christie, 2002).

A ‘condition’, as opposed to a ‘definition’, is more authoritative. Thus the ideology of the authoritative nature of science permeates Triadic Dialogue 1B and plays a role in shaping the ‘developmental path’ of the language of science.

4.4.3 STAGE III

M57	T	°but..these two forces..these two forces..of EIGHT and seven.. # were balanced by this force°...
M58		remember #
M59		these two forces..
M60		they # accelerated..
M61		and # needed a a force to BALANCE those forces
M62		not to ACCELERATE...
M63		°which # force balanced them?°..
M64		yes?
M65	L	the one newton force
M66	T	the?..ONE newton force # was used to balance

M67 what?..the resul- sorry these two forces
 M68 but these two forces # had a resultant..this way..
 M69 so THIS force is a force that does what?..that
 M70 balances what?
 M69 **L** [unclear]
 M70 **T** no
 M71 zero point eight and zero point seven # have a
 M72 resultant of one newton..
 M73 [code-switches] [there it is]
 M74 **T** **right now**..these two forces
 M75 **when we # did not have** this force downwards
 M76 here
 M75 this # ACCELERATED this way
 M76 **we # then put in** another force here to do what?
 M77 **L** to balance the two forces
 M78 **T** to BALANCE the two forces..
 M79 so this # is a force that does what?...that?
 M80 **L** balances
 M81 **T** that BALANCES these two forces..
 M82 it # is a FORCE that BALANCES
 M83 **we # actually put** a force **here** of what? of, of a
 M84 hundred..grams equal..one newton
 M85 and it # became
 M86 it
 M87 the whole thing # shifted
 M88 and # became like this..
 M89 it it # made this thing to come...to rest..
 M90 it # actually made..the resultant..to do what?
 M91 repetition4 ...
 M92 it # made the resultant do what? repetition4
 M93 yes?
 M92 **L** it # made it zero
 M93 **T** **I # agree**
 M94 **you # are actually quite correct**
 M95 once something # is at rest
 M96 the resultant # is
 M97 **Ls** zero
 M98 **T** zero
 M99 the resultant force acting on that THING # is zero

As the text unfolds in Triadic Dialogue 4H the text becomes less and less ambiguous as the learners acquire new language.

For example, in *Stage III*, Mr. Maletto and the learners refer to ‘the equilibrant’ as ‘the one newton force’ [M65] even though there are two forces, namely ‘the equilibrant’ and ‘the resultant’, which have a magnitude of one newton.

In addition, in *Stage III*, Mr. Maletto and the learners refer to ‘the resultant for F_1 and F_2 ’ and ‘the resultant for apparatus (1)’ simply as ‘the resultant’ [M89] even though the magnitude for the former is 1.0N and the magnitude for the latter, 0N.

It is only in *Stage VI* when the key lexical item ‘the equilibrant’ is introduced, and later on in Lesson H [12.1H-12.19H] when the forces in the system are labeled ‘ F_1 ’, ‘ F_2 ’ and ‘ F_3 ’, that the text becomes less ambiguous and it is possible to make a distinction between the ‘equilibrant’ and the ‘resultant’ as well as ‘the resultant for F_1 and F_2 ’ and the ‘resultant for apparatus (1)’.

To overcome this ambiguity in *Stages I – VIII* Mr. Maletto makes extensive use of ‘exophoric reference’ [also M2; M3; M8; M9; M13; M14; M20; M24; M34; M36; M37; M39; M40; M43; M55; M56; M57; M59; M61; M66; M67; M68; M73; M74; M75; M79; M87; M99; M101; M107; M115; M118; M119; M120; M121; M123; M130; M131; M134; M140; M144; M146; M156; M157; M164; M170] and ‘reference to location in space’ [also M15; M19; M24; M25; M27; M53; M55; M74; M76; M83; M109; M112; M114; M121; M123; M140; M146] (Martin and Rose, 2003).

To conclude, it is thus evident from *Stage III*, that as the text unfolds, and the context in which the language is used expands, so the introduction of new language is important to ‘talk’ science in the science classroom.

4.4.4 STAGE IV

M100	T	NOW, NOW ..°can you # give,..
M101		can you # define..this force?..

As the text unfolds in Triadic Dialogue 4H the learners are prompted to introduce new language. For example, in *Stage IV* Mr. Maleto, using apparatus (1), points out ‘F₃’ to the learners and states ‘**now now can you give** [a name for this force]? [M100] and ‘**can you define this force?**’ [M101]. The learners thus play a central role in the creation of the ‘developmental history’ for a discourse community.

4.4.5 STAGE V

M102	T	the force acting downward.. # is a force that does what?°
M103		[name]
M104	L	that balances
M105	T	that BALANCES?
M106	L	all forces
M107	T	ALL forces acting at this point..

As the text unfolds in Triadic Dialogue 4H the learners acquire new language and the ‘reasoning’ encoded in it (Christie, 2002).

For example, in *Stage V* Mr. Maleto constructs the following argument, namely that ‘F₃’ produces equilibrium for ‘F₁’ and ‘F₂’ because of the ‘first condition’ taught in *Stage II*.

M108	T	NOW we # THINK
M109		there # is a point here ^{repetition5}
M110		ne?..
M111		now we # think
M112		you know there # is a point here ^{repetition5} ..
M113		[code-switches] [before]
M114		there # is a point here ^{repetition5}
M115		and I # ’ve got two forces acting on this point
M116		but now suddenly I # have now
M117		[code-switches] [what]
M118		THIS force # balances the forces acting on that point
M119		WHY? because this force # ACTS in this direction
M120		and this one # ACTS in that direction...
M121		if this force # was not here..

M122		sorry..
M123		if this force # was not there..
M124		what # would be
M125		what # do you think would actually happen?...
M126		yes?
M127	L	the whole system # would collapse
M128	T	>the WHOLE SYSTEM # would COLLAPSE<
M129		[code-switches] [she is right]

To construct his argument Mr. Maletto employs ‘reasoning’, i.e. where reasoning is a way of talking something through and a way of using logic. Lemke (1993:122) states:

reasoning is primarily a way of talking, including a way of writing and a way of talking to ourselves (“inner speech”). We learn it by talking to other members of our community, we practice it by talking to others, and we use it in talking to them, in talking to ourselves, and in writing and other forms of more complex activity

In addition, Lemke (1993) states that ‘reasoning’ is logical because it lays out an argument in a particular way. Mr. Maletto’s argument is laid out in *Stage V* so that it has a Major Premise, Minor Premise and a Conclusion (Lemke, 1993).

Firstly, the Major Premise underlying Mr. Maletto’s argument is that ‘this force [F_3] balances the forces [F_1] and [F_2] acting on that point’ [M118] and that ‘if this force was not there...the whole system would collapse’ [M123-M128].

Secondly, the Minor Premise underlying Mr. Maletto’s argument is that ‘there is a point here’ [M109] and that ‘**I’ve got** two forces acting on this point’ [M115] where ‘this force [F_1] acts in this direction’ [M119] and ‘this one [F_2] acts in that direction’ [M120].

M130	T	right..SO,SO, this force # is a force..that
		BALANCES..that balances the two forces..
M131		°so..this force we found out it is equal to what?°
M132	L	to the resultant
M133	T	to the resultant force
M134		so this force

M135		so a force..that BALANCES..OTHER FORCES
M136		[code-switches]
M137		a force..that BALANCES..OTHER FORCES.. # MUST be equal to what?
M138	Ls	to the resultant force
M139	T	>TO THE RESULTANT FORCE<..
M140		so here THIS FORCE.. # BALANCES the..the other..forces..
M141		it # balances them ^{repetition6} ..
M142		right?..
M143		°it # balances them ^{repetition6} ..
M144		but this force.. # is the resultant..
M145		now.. these two forces # ARE? EQUAL

Thirdly, Mr. Maleto concludes his argument in *Stage V* when he states ‘a force that balances other forces must be equal to the resultant force’ [M137-M139] using the finite verbal operator ‘must’ [M137] to express a high degree of probability that ‘these forces [‘F₃’ and ‘-F₃’] are equal’ [M145].

When Mr. Maleto formulates his logical argument in *Stage V* he uses the ‘consequential conjunctions of cause’ ‘so’ [M130; M131; M137; M138; M140; M164] and ‘because’ [M119] as well as ‘the consequential conjunction of condition’ ‘if’ [M121; M123] (Martin and Rose, 2003). A shift towards the use of consequential conjunctions indicates a movement away from the ‘here-and-now’ of everyday discourse towards more abstract discourse (Veel, 1997). In addition, Mr. Maleto uses the ‘force diagram’ of apparatus (1), as shown in *Figure 4.4.5-I* below, when he formulates his logical argument in *Stage V*; Mr. Maleto erases ‘F₃’ as he states ‘if this force [‘F₃’] were not there **what do you think would actually happen?**’ [M123-M125].

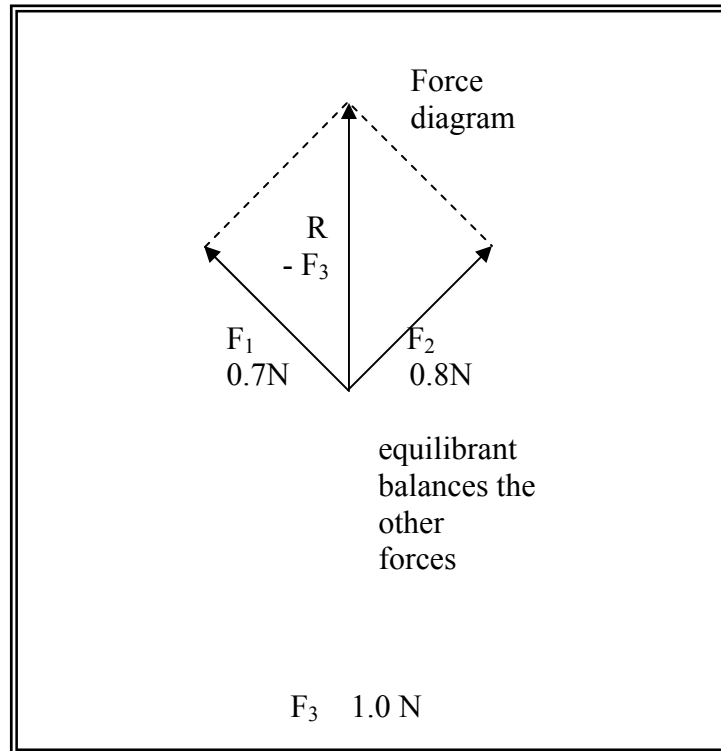


Figure 4.4.5-I Chalkboard (6)

To conclude, it is thus evident that the learners gain new language and the ‘reasoning’,³² encoded in it as they participate as members of a discourse community in the science classroom.

4.4.6 STAGE VI

- M146 **T** **now we # want to use a SPECIAL name here to to to give** you know this force that balances you know other forces
- M147 **>who knows<?...**
- M148 **am I # teaching three people here?**^{repetition7} ...
- M149 **am I # teaching three people here?**^{repetition7}

³² ‘Reasoning’ over ‘affect’ is given a privileged status in the science classroom (Lemke, 1993). The privileged status given to ‘reasoning’ in Mr. Maletto’s class is evident from the statement written on the front cover of the Teacher Support Materials used by Mr. Maletto to teach ‘vectors’. It states “Reason is your greatest tool. It creates an atmosphere of understanding which leads to knowledge.” However, as discussed in Triadic Dialogue 1B, positive affect also plays a central role in Mr. Maletto’s class as it is loaded onto the different meaning making practices. Thus the learners also gain new language and the affect encoded in it.

M150		it # 's very easy for me to say you know
M151		get out #
M152		and # run back
M153		[code- switches] [here now]
M154		yes?
M155		[code-switches] [it is funny that you do not know this because you have it written on your worksheet]
M156		yes?..yes?..eh he..THIS FORCE # is EQUAL to THIS FORCE
M157		let's # now form a NEW word..you know for this force...
M158		yes?
M159	L	equilibrant
M160	T	it # 's the?
M161	L	equilibrant
M162	T	the equilibrant
M163		yes

As the text unfolds in Triadic Dialogue 4H the learners begin to appropriate new language.

For example, in *Stage VI* 'F₃' is named. Mr. Maletto uses the process of affection '**want**' [M146] together with the resource of appraisal to express his attitude towards the name when he states '**now we want to use a special name here to give you know this force that balances you know other forces**' [M146]. In addition, Mr. Maletto uses the material process '**form**' [M157] when he states '**let's now form a new word you know for this force** ['F₃'] [M157].

In the move Learner Response the '**new word**' [M157] is provided; a learner states 'equilibrant' [M161].

4.4.7 STAGE VII

M164	T	so..this # is called...the equilibrant ..
M165		it # is a force that BALANCES..other forces..
M166		what do we know about a force that balances

M167		other forces # is that [code-switches] [it will always be]
M168		[it] # is equal to what?
M169	L	to the resultant
M170	T	to the RESULTANT of those two forces

As in *Stage II*, it is evident in *Stage VII*, that as the text unfolds in Triadic Dialogue 4H information is repeated, i.e. there is ‘redundancy’ (Lemke, 1995).

For example, Mr. Maleto uses the ‘force diagram’ of apparatus (1) in *Stage VII* to review *Stages I – VI*. Mr. Maleto reiterates that ‘ F_3 ’ is equal to ‘ $-F_3$ ’ [M168-M170]; that ‘ F_3 ’ is the force that produces equilibrium for ‘ F_1 ’ and ‘ F_2 ’ [M165]; and that ‘ F_3 ’ is called the ‘equilibrant’ [M164].

Christie (2002) states that it is in the redundant processes of application and re-application of key lexical items that ‘logogenesis’ occurs.

4.4.8 STAGE VIII

M171	T	what # is the SECOND..condition..of the equilibrant?
M172		what # is the SECOND thing about you know about the equilibrant?...
M173		eh?
M174		one condition # is that
M175		the equilibrant # is always equal to the?..resultant force
M176		number two?...
M177		[name]?
M178	L	it # acts in the same straight line as the resultant
M179	T	it # ACTS in the SAME STRAIGHT LINE as the RESULTANT,
M180		very good,
M181		yes?
M182	L	but [it # acts] in the opposite direction
M183	T	BUT [it # acts] in the opposite direction
M184		very good boy, very good..
M185		in the opposite direction

M186	that # 's what the equilibrant is..
M187	NOW, now, now [unclear]...
M188	clean # the board for me please you know this side [unclear]

As in *Stage VI*, it is evident in *Stage VIII*, that as the text unfolds in Triadic Dialogue 4H the learners begin to appropriate new language.

For example, a learner states the second ‘condition’ [M171] in *Stage VIII* for the equilibrant, namely ‘it [the equilibrant] acts in the same straight line as the resultant but in the opposite direction’ [M179-M182] (*Figure 4.4.8-I* below).

it [the equilibrant]	acts
Actor	Pr: material

in	the	same	straight	line	as	the	resultant
Circ: manner							

but	in	the	opposite	direction
Circ: manner				

Figure 4.4.8-I Analysis of Transitivity for M179-M182

Christie (2002:159) states that one measure of the successful unfolding and completion of a unit of work is the presence of ‘logogenesis’, i.e. “a process by which the language changes as students move to control of new language and hence of new understandings”.

CONCLUSION

As Triadic Dialogue 4H unfolds a ‘developmental history’ for the unit ‘mechanics’ is revealed.

Firstly, the ‘developmental history’ is revealed in grade 11 when the key lexical items taught explicitly in grade 10 are:

- 1) now taught implicitly;
- 2) used and reused in a different context, i.e. there is ‘redundancy’;
- 3) and used to define new key lexical items.

Secondly, the ‘developmental history’ is revealed when the grade 11 learners:

- 1) gain new language (which was shown to be important in ‘talking’ science as the context in which the language is used expands);
- 2) and gain the reasoning (and affect) encoded in the language.

Thirdly, it was shown that the learners play a central role in the creation of a ‘developmental history’ and that a ‘developmental history’ for a key lexical item may be present in one class and absent in another depending on the choices made by the teacher in the teaching and learning process.

Lastly, the term ‘developmental path’ was adopted to illustrate the dynamic way in which language is transformed when ideology comes in to play as it is used and reused in different contexts; the net result being a ‘developmental path’ for a key lexical item that is idiosyncratic for a discourse community.

CONCLUSION FOR DATA INTERPRETATION AND ANALYSIS

In Chapter 4 I gave a report on the interpretation and analysis of the data. Linguistic evidence was provided for the power and control relations that operate in an episode of classroom interaction, and for the regulation of the learners’ behaviour in terms of acceptably ‘good’ behaviour and the induction of the learners into the ‘languages’ of science.

In 4.1 – 4.4, it is evident that ‘waves’ (Martin and Rose, 2003) of strong and weak classification and framing mark the various episodes of classroom interaction. This has

implications in terms of what is 'learnt' in the classroom: the language, the 'content' constructed and communicated, and the values and beliefs about 'doing' science that are transferred.

In addition, in 4.1 – 4.4, it is evident that the learners are positioned and repositioned as the various episodes unfold, mirrored by the 'waves' of strong and weak classification and framing. This has implications in terms of the 'ideal pedagogic subject position' constructed: the 'ideal pedagogic subject position' associated with acceptably 'good' behaviour, verbal language, and mathematical and visual literacies having been explored.

In 4.4, the different models of pedagogy that operate within a class are revealed by whether or not a 'developmental history' for a scientific term can be traced back to the previous grade. In addition, the central role the learners play in the creation of a developmental history is evident. The notion of a 'developmental history' is extended in this study to include the developmental path for a scientific term: as a term is used and reused in different contexts ideology comes into play, transforming the language. This 'transformation', at times, perpetuates the 'mystique' (Lemke, 1993) of science.

Finally, the manner in which Mr. Maleto and Mrs. McKenzie equip their bilingual learners to be 'successful' in the context of the South African classroom was discussed. In particular, attention was drawn to how the learners are aided in acquiring the 'recognition' and 'realization' rules, discussed in 2.1.1, needed to recognize and produce the 'legitimate' text.

These findings are explored further in the following chapter.

CHAPTER 5

CONCLUSION

This study has sought to answer the question: “How are these learners apprenticed to be science learners and what is the ‘ideal pedagogic subject position’?” In Chapter 5, I return to the research question and examine the findings of this study by using the following framework to analyse and reveal how the apprenticeship of the learner in the science classroom is constructed:

- (1) Apprenticeship at the micro level of classroom interaction;
- (2) Apprenticeship and the role of the teacher and learner;
- (3) Apprenticeship and the regulation of the learners’ behaviour;
- (4) Apprenticeship over time; and
- (5) Apprenticeship and the construction of the science learner.

Upon examination of the findings in this chapter attention is drawn to the following aspects: (1) What has been learnt from this study; (2) How the theories used have been extended for the purposes of this study; (3) Where the findings of this study coincide and do not coincide with the findings of previous research that has been done; and (4) What the implications of the findings are for teachers, teacher educators, and researchers. Finally, the strengths and limitations of this study are discussed and areas for further research are proposed.

5.1 APPRENTICESHIP AT THE MICRO LEVEL OF CLASSROOM INTERACTION

The apprenticeship of the learner at the micro level of classroom interaction has been shown in this study to be a dynamic process mirrored by the power and control relations that operate variously in the classroom discourse. The ‘choices’ teachers and learners make to do with power and control shape the language, content, values and beliefs in the science classroom:

(1) Choices are made dealing with ‘content’ in the science classroom

For example, to teach the concept of ‘force’ Mr. Maleto and Mrs. McKenzie make different choices associated with commonsense and uncommonsense knowledge. Mr. Maleto uses examples from ‘the everyday’; he pushes against the classroom wall and he bends an eraser to demonstrate force. Mrs. McKenzie also uses an example from ‘the everyday’, however, she relates the example to school knowledge; she pushes against a stapler to demonstrate force and asks the learners to draw a force diagram.

A teacher’s choice to do with commonsense/ uncommonsense knowledge is likely to be influenced by his/ her understanding of the distinction made between these two elements. In the lessons observed, Mr. Maleto did not appear to recognize the disjuncture that exists between the two; Mr. Maleto asked his learners “In nature and in our homes, where do you normally get forces acting like this?...There are so many, but you don’t observe these things.” As a result, Mr. Maleto’s learners tended to remain within ‘the everyday’ in terms of their understanding of ‘force’, as was evident, in part, from the learners’ responses during the ‘brainstorming session’ in 4.1.4.

The apprenticeship of the learner into science thus involves navigating the boundary that exists between ‘the everyday’ and ‘the scientific’. In order to do so, the learners need to learn how to move between these two elements that define the science classroom.

In terms of ‘content’, these findings reveal how teachers and learners successfully and unsuccessfully move between ‘the everyday’ and ‘scientific’. As discussed in 2.1.6 Curriculum 2005 gives special importance to the ‘the everyday’. Although I can sympathize with the underlying motive of making the curriculum relevant to the learners’ day-to-day lives by placing an emphasis on ‘the everyday’, these findings would seem to suggest that caution needs be taken in doing so, to ensure that there is clarity for learners about the extent to which scientific principles are visible in ‘the everyday’.

(2) Choices are made dealing with language in the science classroom

For example, to teach the concept of ‘gravity’ Mr. Maletto and Mrs. McKenzie make different choices associated with scientific discourse. Mr. Maletto insists on the learners using the phrase ‘gravitational force’ and/or ‘the force exerted by gravity’ instead of ‘force of gravity’. In contrast, Mrs. McKenzie insists on the learners using the phrase ‘force of gravity’ and/ or ‘acceleration due to gravity’ instead of ‘gravity’. Mr. Maletto, Mrs. McKenzie and the learners also use the phrase ‘force of the earth’ variously in the classroom discourse – at times, to mean the complete opposite of what was intended by the other.

The apprenticeship of the learner is thus, to some degree, an apprenticeship into a language that is idiosyncratic to a teacher and his/ her learners. In addition, the apprenticeship of the learner in the science classroom involves effort due to the ambiguous nature of the language of science.

In terms of ‘language’, these findings reveal the role of scientific discourse in the classroom; a discourse that is dynamic, not static, and one that plays an important role in ‘talking’ science in the classroom. As discussed in 2.1.6, Curriculum 2005 emphasizes non-scientific discourse and scientific discourse. Although I would not dispute that non-scientific discourse has a role to play in the science classroom, these findings would suggest that the importance of scientific discourse should not be underplayed.

In addition, these findings reveal some of the difficulties that the language of science presents in ‘talking’ science in the classroom. As discussed in the Introduction, language has been recognized as a significant factor for the low levels of enrolment and performance in physical science. In this study, the following statement made by Mrs. McKenzie captures the way in which language and measured forms of performance in the science classroom can be directly linked to each other:

I can't tell you how many times I've seen exam papers [scripts] with arrows pointing up for the force of the earth [emphasis mine], which is obviously not, you know, if I drop my pen [Mrs. McKenzie drops her pen] what does it do? It goes down. The earth pulls on it, right?

I would propose that for a teacher to be able to diagnose a problem to do with language correctly, and to be in a position to be able to correct it, he/ she would need to be made conscious of the features of scientific discourse, as explained in 2.1.3.1. In the abovementioned example, this would mean that a teacher would be in the position to ask if the problem was that the learner did not understand that gravity acts downward or if the problem was that the phrase 'force of the earth' was ambiguous due to lexical and grammatical ambiguity. The teacher could then take the appropriate steps to correct the problem; if the problem was to do with language the teacher could 'unpack' the nominal group by stating it variously as, for example, 'the earth exerts a force'.

Another example of the different choices made in terms of language, is provided when the definition for 'the equilibrant' is transformed into two 'conditions' in Mr. Maletto's class. As discussed in 4.4.2 ideology can come into play as a scientific term, such as 'the equilibrant', is used and reused in different contexts in the 'delocation', 'relocation' and 'transmission' of knowledge. A 'condition', as opposed to a 'definition', is more authoritative. Thus the ideology of the authoritative nature of science permeates the classroom discourse.

The apprenticeship of the learner into science is thus, to some degree, an apprenticeship into a subcommunity with its own specialized forms of communication. Although it is evident from the abovementioned example that the 'teacher talk' in the science classroom can perpetuate the 'mystique' of science, linguistic evidence is also provided in 4.1.3 that reveals the authority of Mr. Maletto as he opens the door for his learners to enter into this particular subcommunity.

In terms of the notion of ideology, these findings highlight one of the important roles that a teacher plays in the science classroom. As discussed in 2.1.6, Curriculum 2005

emphasizes the role of the teacher to be that of facilitator in the science classroom. Although I would not dispute that the role of the teacher as facilitator is an important one, these findings would suggest that the role of the teacher as authority in the science classroom is also significant in terms of who gains access to the language of science.

(3) Lastly, as reported on in 4.1, choices are made dealing with the selection of the communication, the pacing of the lesson, the criteria of evaluation, and hierarchical relations.

In this study the shifts and changes in the power and control relations that mark the relationship of apprenticeship are translated into ‘waves’ of stronger and weaker classification and framing. For example, in 4.1, waves of stronger classification and framing are evident when Mr. Maletto sets the context/ field at the macro level, models scientific discourse, and repeatedly focuses and refocuses his learners’ attention on key ideas for ‘the lesson’. In contrast, waves of weaker classification and framing are evident when Mr. Maletto repeats and rephrases questions in response to his learners, invites his learners to participate in the lesson, uses examples from ‘the everyday’, and when he and his learners engage in a ‘brainstorming session’.

The shifts and changes in power and control appear to serve different purposes in the relationship of apprenticeship. For example (1) By strengthening the classification and framing the learners can learn to integrate multiple literacies in the science classroom and to use the technical verbal language of science; and (2) By weakening the classification and framing the teacher can build a positive socio-affective disposition towards the text to be produced and simultaneously provide access to both ‘the everyday’ and ‘the scientific’.

These findings are helpful in terms of understanding the apprenticeship of the learners into science in ways that move beyond the characterization of teaching and learning as ‘traditional’, associated with strong classification and framing, or ‘progressivist’, associated with weak classification and framing. In addition, as the context for the

apprenticeship of the learner into science is the Activity Type Triadic Dialogue, these findings are helpful in moving beyond the “somewhat undifferentiated manner” (Wells, 1999:168) in which the Activity Type has typically been treated. Triadic Dialogue has been shown in this study to serve different functions reflected by the waves of stronger and weaker classification and framing that mark the classroom discourse.

As discussed in 2.2, a ‘traditional’ and a ‘progressive’ model of pedagogy are “jostling for dominance” (Muller, 2000:105) during this time of curriculum reform. These findings are therefore useful to teachers and researchers when evaluating good teaching practice in South Africa as this study begins to uncover the complexities of the teaching and learning process in ways that move beyond this dichotomy. As has been proposed by Christie (2002), Cope and Kalantzis (1993), Martin and Rose (in press), and Wells (1999) these findings would suggest that both models have something to offer.

5.2 APPRENTICESHIP AND THE ROLE OF THE TEACHER AND LEARNER

In the apprenticeship of the learner into science the notion of ‘choice’ to do with language, ‘content’, values and beliefs, discussed in 5.1, suggests a degree of agency. In this regard, Muller (2000:19) claims that there are mechanisms, such as the Senior Certificate Examination, which restrain teachers from making choices that deform knowledge in the process of recontextualization; he states:

Both the teacher and the school are judged according to the performance of the students at this final hurdle, and it is this device more than any other that predisposes the teacher to speak in *loco administratus* rather than in the name of the community, his or her conscience or perception of the truth, civic usefulness or any other principle.

Although, it is acknowledged that an examination would play a role in shaping the language, content, values and beliefs taught in the science classroom, it is evident from this study that Mr. Maleto and Mrs. McKenzie do not always speak in *loco administratus*; instead Mr. Maleto and Mrs. McKenzie speak in ways that are to some degree idiosyncratic to their science classroom. For example, in this study, Mr. Maleto’s attitude

towards the ‘correctness’ of the definition for ‘displacement’ in the textbook meant that the definition was transformed in the ‘delocation’, ‘relocation’, and ‘transmission’ of knowledge; Mr. Maleto stated:

Never say change in displacement. Right, I know books say that. They are wrong [emphasis mine]. You see you can’t change a change in position because the word displacement itself means what change in position. So I can’t say velocity is the rate of change of displacement. It is just the rate of what of change of position. [repetitions omitted]

These findings suggest that Mr. Maleto and Mrs. McKenzie are not simply passive implementers of the curriculum, but instead ‘actors’, who having been apprenticed into science themselves, play a significant role in the construction of the curriculum in the science classroom (Murray, 2006).

In addition to the teachers being ‘agents’ of control in this study, the learners have also been shown to be an ‘agents’ of control. For example, when Mr. Maleto repeatedly asks the learners ‘Do you agree?’ during the ‘brainstorming session’ in 4.1.4 there is no response causing Mr. Maleto to state ‘Yes, I agree.’ These findings suggest that the learners also play a significant role in determining the control relations that operate in the science classroom. A greater emphasis is thus placed in this study on the agency of the learner at the micro level of classroom interaction than the theory of Bernstein, discussed in 2.1.2, suggests.

5.3 APPRENTICESHIP AND THE REGULATION OF THE LEARNERS’ BEHAVIOUR

This study provides linguistic evidence for the regulation of the learners’ behaviour associated with acceptably ‘good’ behaviour and the induction of the learners into the ‘languages’ of science.

These findings, similarly to those of Christie (2002), suggest that there is only ‘one discourse’. This has implications for treating ‘values’ as separate to ‘competences’ as in

Curriculum 2005, discussed in 2.1.6, which refers to ‘values’, ‘knowledge’, and ‘skills’ as three separate learning outcomes.

In addition, these findings, similarly to those of Lemke (2000), emphasize the central role multiple literacies play in communication in the science classroom. A similar reaction to that taken by Lemke (n.d.a), on closer examination of the data generated for a science classroom, could be elicited by these findings; Lemke (n.d.a:9) states:

...even I was astonished at how many different semiotic systems John [a learner in the science classroom] had to integrate and make use of in every few minutes of time in the classroom.

Curriculum 2005, as discussed in 4.3.4, emphasizes the importance of teaching ‘multimodal’ literacies. The findings for this study begin to reveal what it means to teach multimodal literacies in the science classroom and how two ‘successful’ teachers equip their bilingual learners in South African science classroom to be able to do so.

In this study Mr. Maleto and Mrs. McKenzie equip their learners to be ‘successful’ learners by (1) Focusing their learners’ attention on key ideas and establishing some form of connectedness between key ideas; (2) Engaging the learners and providing them with multiple opportunities to use the key lexical items; (3) Making evaluation criteria for text production explicit; (4) Using ‘formulaic expressions’ repeatedly to aid the learners in acquiring the ‘recognition’ and the ‘realization rules’ for text production; (5) Choosing the appropriate time to introduce certain of the semiotic resources so that the learners had less to process at a given time; (6) Using a metalanguage to talk about the different semiotic resources; and (7) Giving explicit instruction in being able to move back and forth between the different verbal, mathematical and visual literacies.

These findings would suggest that further research is needed into the practice of teachers in South Africa so that existing good practice can be preserved and not undermined and so that a model of pedagogy that sees the value in ‘cultural reproduction’ and ‘individual

development' can evolve to incorporate the varied and complex strategies that teachers draw upon in practice to assist their learners.

5.4 APPRENTICESHIP OVER TIME

The apprenticeship of the learner over time has been shown to be significant in this study in terms of 'talking' science as a unit of work unfolds. Key lexical items taught explicitly in the grade 10 classroom were taught implicitly in the grade 11 classroom, used and reused in different contexts, and used to define new key lexical items.

The apprenticeship of the learner into science thus involves, to some degree, gaining new language and the reasoning (and affect) encoded in that language. This, as reported on in 4.4, is important in terms of 'talking' science as the context in which the language is used expands.

These findings highlight the importance of progression across a unit of work. As discussed in 2.1.6, the notion of progression is emphasized in Curriculum 2005. Linguistic evidence is provided in this study for the notion of progression. In addition, as discussed in 5.2, greater agency is ascribed to the learner in this study in terms of the creation of a 'developmental history' for a discourse community.

This study also reveals that a 'developmental history' for a key lexical item can or cannot be traced back in time depending on the choices made by the teacher in the apprenticeship of the learner in the science classroom. For example, Mr. Maletto teaches the concept of a 'resultant force' by pushing against the classroom wall without explicitly talking about the concept of a resultant force or extending the demonstration to include school knowledge. Mrs. McKenzie, on the other hand, explains the concept of a resultant force by pushing against a stapler on the desk and getting the learners to draw a force diagram for the stapler. Furthermore, the lessons observed and the notes collected for the first two terms of the school year for grades 10 and 11 show that Mr. Maletto chooses to teach force diagrams in grade 11, not grade 10. A developmental history for the key

lexical item ‘the resultant force’ used in Mr. Maleto’s grade 11 class could therefore not be traced to grade 10.

Mr. Maleto and Mrs. McKenzie’s decision to teach the resultant force differently might thus be said to have different implications. On the one hand, the attention of Mr. Maleto’s learners might have been captured in ‘doing science’ as they participated in a demonstration that was performed with much dramatic effect, and yet on the other, Mrs. McKenzie’s learners might have been better prepared to move between ‘everyday’ and ‘school’ knowledge.

These findings would suggest that teachers need to be made conscious of the implications of making different decisions so that the decisions that they make can be informed decisions.

5.5 APPRENTICESHIP AND THE CONSTRUCTION OF THE LEARNER

The construction of the science learner in terms of acceptably ‘good’ behaviour and the induction of the learner into the ‘languages’ of science has been explored in this study in the classroom discourse.

(a) In terms of what constitutes acceptably ‘good’ behaviour the ‘ideal pedagogic subject position’ constructed in Mr. Maleto and/ or Mrs. McKenzie’s class is a learner who is diligent, attentive, participates in the lesson, organized, works neatly, and is accountable. The ideal pedagogic subject position is constructed when Mr. Maleto and/ or Mrs. McKenzie state categorically what they and the learners are ‘to do’ in the lesson, direct the course and the pace of the lesson, place the onus on the learners to be responsible, and expect the learners to be organized and work neatly.

(b) In terms of the apprenticeship of the learner into the discourse of science (and the reasoning encoded in it) the ‘ideal pedagogic subject position’ constructed in Mr. Maleto and/ or Mrs. McKenzie’s class is a learner who is (1) Able to integrate the correct

scientific term or ‘rule’ and deploy it in ‘talking’ science, as well as provide the correct definition for a scientific term; and (2) Able to integrate multiple literacies “quickly and fluently in real time” (Lemke, 2000:247), use ‘symbols’, and remember to include the ‘units’ when solving a problem in the science classroom. The ideal pedagogic subject position is constructed when Mr. Maleto and/ or Mrs. McKenzie teach the scientific terms and their respective definitions, insist on the scientific terms being used accurately, teach multiple literacies implicitly and explicitly, state categorically ‘this is how things are done in mathematics/ science’, and refer directly and indirectly to the ideal pedagogic subject position.

(c) In addition, in terms of the apprenticeship of the learner into the discourse of science (and the reasoning encoded in it) the ‘ideal pedagogic subject position’ constructed in Mr. Maleto and/ or Mrs. McKenzie’s class is a learner who is (1) Able to ‘brainstorm’ ideas; (2) Able to think and reason using verbal language; and (3) Able to take notes independently. The ideal pedagogic subject position is constructed when Mr. Maleto and/ or Mrs. McKenzie encourage whole class participation and the learners to work independently.

The former ideal pedagogic subject position, i.e. ideal pedagogic subject position ‘(b)’, is constructed in the pedagogic discourse when the power and control relations for the science classroom are marked by waves of stronger classification and framing and the latter, i.e. ideal pedagogic subject position ‘(c)’, when the power and control relations for the science classroom are marked by waves of weaker classification and framing.

These findings enable teachers, teacher educators and researchers to reflect critically upon how desirable such an ideal pedagogic subject position is in the context of the South African science classroom – Are the practices, values and beliefs that constitute the ‘ideal pedagogic subject position’ those that we hope to ‘teach’? How closely aligned are these practices, values and beliefs to those stated in policy documents, as discussed in 2.1.6? As reported on in 4.2.4 values, such as ‘accountability’ to do with class work, homework

and attendance, foregrounded in Mr. Maletto and Mrs. McKenzie's class are one of the six values named in *The Manifesto on Values, Education and Democracy*.

These findings also show how a learner can be positioned and repositioned in the relationship of apprenticeship as an episode of classroom interaction unfolds – the shifts and changes in the pedagogic subject position reflected by the waves of stronger and weaker classification and framing that mark the pedagogic activity. These findings would therefore once more seem to counter the view that underlies the “superficiality of the progressivist/ traditional ideological conflict” (Rose, 2004:4) that would characterize the construction of the ideal pedagogic subject position as an either/ or instead of involving shifts and changes mirrored by a complex “system of doings” (Lemke, 1995:93) at the micro level of classroom interaction.

5.6 THE STRENGTHS AND LIMITATIONS OF THE STUDY

The theoretical framework that I adopted to do research into classroom practice in this study has certain strengths and limitations. These include strengths and limitations to do with (1) The interdisciplinary nature of the study; (2) The communities of practice investigated; (3) Language as the principal semiotic system of interest; (4) The ‘developmental model’ and SFL used in the analysis; and (5) The Activity Type Triadic Dialogue as a “principled basis” (Christie, 2002:222) for the selection of texts. The strengths and limitations of this study are listed below.

(1) Firstly, this study, as an interdisciplinary study to do with language and science, meant that boundaries were pushed, in particular in terms of multimodal literacies. However, writing in two discourses, the discourse of science and the discourse of linguistics, poses challenges in terms of making the findings accessible to a broad range of readers.

(2) Secondly, the communities of practice investigated in-depth, and over an extended period of time, allowed certain elements that define the pedagogic social context, such as

‘progression’, to be investigated in this study. However, understanding how the language of one subcommunity differs to another, has as a result been limited to only two.

(3) Thirdly, language, as the principal social semiotic system of interest is pertinent due to the recognition that has been given to language as a factor that contributes to low levels of enrolment and performance in physical science: understanding what teaching and learning science through language encompasses is therefore important. However, language is only one of many ways in which meaning is made in the classroom. The arrangement of the classroom, the teacher and the learners’ clothing and body language, the space between the teacher and the learners, etc. are all significant factors in terms of the power and control relations that define the science classroom.

(4) Fourthly, Systemic Functional Linguistics (SFL) as the principal mode of analysis is useful as a tool of analysis for examining teaching and learning through the language of science at the micro level of classroom interaction. However, the time taken to analyse a text, and the detail that is uncovered, limits the number of texts that can be analyzed and presented.

In addition, SFL as a canonical method of discourse analysis lays the ground for others to enter into the discussion and compare their findings to the interpretations made in this study (Lemke, 1998a). However, it is *most* developed for verbal (and written) language, not visual and mathematical literacies. As a result, research is needed into using SFL as a multimodal tool of analysis to better understand how multiple literacies are integrated.

(5) Fifthly, The ‘developmental model’ (Christie, 2002) as a tool of analysis is valuable in linking Bernstein’s notion of ‘power and control’, ‘moral regulation’, and ‘progression’ to ‘language’. In addition, the theory of Bernstein is useful in terms of doing research into issues that speak to the current context of education in South Africa. However, the theory of Bernstein is abstract, and a number of the terms, such as ‘recontextualization’, are only broadly defined (It is acknowledged that this suits the purposes of the theory which is to be applicable in a wide range of contexts (Bernstein,

2000)). Research is thus needed into using the theory of Bernstein as a tool of analysis in order to forge links between theory and practice.

(6) Lastly, the Activity Type ‘Triadic Dialogue’ enables texts to be selected on a “principled basis” (Christie, 2002:22). In addition, it is the most common Activity Type (Lemke, 1993) and is therefore relevant to most educational contexts. However, as the most common Activity Type the selection of texts (recognized to be a problem in doing research into verbal language (Christie, 2002)) is made more difficult.

5.7 CONCLUDING STATEMENTS AND AREAS FOR FURTHER RESEARCH

In this study a large amount of ground has been covered to understand the complexity of the problem of language for bilingual learners in the physical science classroom in South Africa.

The language of science has been extended to include verbal (and written), mathematical and visual literacies, and linked to content, values and beliefs. The construction of the learner has included an induction into acceptably ‘good’ behaviour, and an induction into all of the ‘languages’ of science. Lastly, the micro level of classroom interaction has been examined to understand the apprenticeship of learner in ways that move beyond the dichotomy of the ‘traditional’/ the ‘progressive’.

A positive move in the direction of raising standards in terms of teaching and learning science has thus been made in this study by presenting to teachers, researchers and teacher educators the need to be conscious of the different components of language. In addition, this study has begun to uncover the complex and varied strategies that teachers draw upon in practice to assist their bilingual learners in the context of the South African classroom.

In conducting further research into language and science in South Africa this study presents the researcher with the possibility of exploring in-depth the issues raised in this

study. For example, the challenges teachers and learners encountered in navigating the boundary between commonsense and uncommonsense knowledge in this study suggests that further research is needed into the induction of the learner into uncommonsense knowledge. In addition, the agency of the learner in the construction of a ‘developmental history’ in this study and in determining the control relations that operate in the science classroom suggests that further research is needed into the role of the learner in the pedagogic relationship. Lastly, the construction of the learner has been examined in the classroom discourse in this study. It too would be insightful to examine the construction of the science learner in the curriculum, textbook and the Senior Certificate Examination.

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