

CHAPTER FIVE: RESULTS – QUALITATIVE DATA

5.1 INTRODUCTION

This chapter used qualitative data to explore all three research questions:

1. How can the transition from the Natural Science in GET to the Physical sciences in the FET be characterized?
2. How do learners in the Gauteng province of South Africa experience the transition from Natural Science in the GET phase to Physical Science in the FET phase?
3. How can learners' strategies and approaches for negotiating the transition be understood and explained?

The chapter starts with a general background that discusses documentation on the Natural Science (grade 9) curriculum and the Physical Science (grade 10) curriculum. I then discussed the analysis of the curricula for scope of coverage, depth of coverage and prerequisite knowledge. The matching of the curricula is in terms of how the GET science (particularly the grade 9 Natural Science) fitted in with the Physical Science in FET, and also whether it provided an adequate basis for learners to study Physical Science in FET.

I focussed on classroom observation to explore the teaching style, content knowledge of the learners and learner interaction, and finally on interviews to hear from learners themselves how they experienced the transition. Interviews attempted to make sense of the cognitive processes that accompany learners' responses (Confrey, 1990). The chapter ends with comments on the results from the qualitative data.

5.2 DOCUMENTATION

In 2005, learners in the GET phase (grade R to grade 9) followed C2005 with the following design features (DoE, 2006(a)):

- 7 Critical and 5 Developmental Outcomes
- 9 Specific Outcomes (Natural Science)

- Assessment Criteria
- Range Statements
- Performance Indicators
- Phase Organisers
- Programme Organisers
- Notional Time

When the learners entered the FET band in 2006, they followed the NCS, a curriculum with streamlined design features (DoE, 2006(a)):

- 7 Critical and 5 Developmental Outcomes
- 3 Learning Outcomes (Natural Science)
- 10 Assessment Standards.

In both bands (the GET and the FET bands) the Critical and Developmental Outcomes stayed the same.

The 9 Natural Science Specific Outcomes were streamlined to 3 Learning Outcomes.

The Assessment Criteria, Range Statements and Performance Indicators have all been streamlined into grade-specific Assessment Standards.

The role and content of Phase Organisers and Programme Organisers have been incorporated into the Learning Outcomes and Assessment Standards.

5.2.1 Changes in prescribed content

In 2005, the grade 9 Natural Science content was left almost entirely to the discretion of the teacher and the school. From 2006, in grade 10 Physical Science, the Assessment Standards indicate content. There is a policy statement for each Learning Area that specifies content that needs to be included. This statement is known as the learning area statement (DoE, 2002(b)). Outcomes encourage local applications of content (DoE, 2006(a)). So the cohort of learners in this study who graduated from the outcomes-based grade 9 in 2005 had to enrol

for grade 10 Physical Science in which content that had to be included was specified. This cohort missed out on the opportunity to follow a content based curriculum in earlier grades. Appendix L shows the content that has to be taught in grade 9 according to the Revised National Curriculum Statement (RNCS) – this was only introduced in 2006. The RNCS was later known as the National Curriculum Statement (NCS). Content was new to the grade 10 learners and OBE principles were new FET teachers. The transition from an outcomes-based system (in which content was left to the discretion of the teacher) to a system in which content was specified represented a potentially serious challenge for both educators and learners because it brought about discontinuity and inconsistency of the curriculum that educators and learners had become familiar with. This is in addition to the fact that transition from GET science to FET science is in itself a challenging transition.

5.2.2 Changes in time allocation

Time allocation has also been streamlined and has been more clearly specified from 2006. The time allocation for Natural Sciences in the GET phase has been increased from 12% in 2005 to 13% of the total contact time as from 2006 (DoE, 2006(a)). So learners in the sample have missed out on the advantages of the increased time allocations when they were in the GET phase.

5.2.3 Documentation required

The Gauteng Department of Education (GDE) noted that it would be very difficult to implement the NCS without the following core curriculum documents (DoE, 2006(a)):

- Learning Area Statement Document
- Teacher's Guide for the Development of Learning Programmes (for each Learning Area)
- National Protocol on Assessment

I also noted that the Education Labour Relations Council had provided school A and school B with a file with all the main education policies. The policies are also available on the DoE website (www.education.gpg.gov.za).

5.2.4 Additional support

The South African government has launched an education portal (www.thutong.org.za) offering a range of curriculum and learner support material from GET to FET, professional development programmes for teachers and administration and management resources for schools. Teachers grappling with the challenges of introducing the national curriculum into classroom practice can download printable, quality-assured resource material that has been extensively cross-referenced against the new curriculum (Source: www.southafrica.info).

5.2.5 Assessment

Continuous assessment (CASS) is an assessment model used to determine a learner's achievement during the course of a grade, provide information that is used to support the learner's development and enable improvements to be made to the learning and teaching process (DoE, 2006(b)). CASS in grade R – 8 comprises of 100% of the assessment programme but only 75% of the total assessment programme in grade 9. A nationally set Common Task for Assessment (CTA) is used as the external summative assessment instrument at the end of grade 9. The CTA is moderated and approved by the General and Further Education and Training Quality Assurance Council (Umalusi) and contributes 25% of the final mark in grade 9 (DoE, 2006(b)). In grade 10 it is the other way round: CASS comprises of 25% of the final mark and the summative examination at the end of the year contributes 75% of the final mark (DoE, 2005(c)). This great difference in methods of assessment for grades 9 and 10 probably contributes to the large retention rate in grade 10, as discussed in the introduction of this thesis.

5.2.6 Matching GET science with FET Physical Science

The Natural Science grade 9 examination was in the form of a CTA that had to be completed within 5-hours, spread over a number of days. The CTA referred to here was based on Curriculum 2005 prior to the implementation of the RNCS. Table 5.1 is taken from the CTA and is an outline of the tasks upon which questions were set. It also outlines the skills that were examined (DoE, 2005(b)). Regarding prerequisite knowledge for grade 10, the DoE identified concepts that ought to be understood in order to cope with grade 10 Physical Science (DoE, 2002(a)). These concepts are listed in Table 5.2. However, comparing these

concepts to the 2005 Natural Science grade 9 examinations (written by learners in this study when they were in grade 9) showed that the examination did not assess whether learners had an adequate basis to study grade 10 Physical Science.

Table 5.2 shows an analysis of scope and depth of coverage of the Curriculum 2005 and the NCS with regard to pre-requisite knowledge for Physical Science in FET. The table shows that the grade 9 learners in this study were not examined on Electricity, Heat and Work, Magnetism, nor Acids and Bases – the concepts that formed the core of pre-requisite knowledge for grade 10 Physical Science. Even the remaining two concepts that were covered, namely Waves and Chemical Reactions, were only dealt with in the context of managing malaria, and there was no in-depth coverage. This leads me to argue that the introduction of the NCS is a tacit admission by the DoE that Curriculum 2005 was creating large gaps of knowledge and was not preparing learners adequately for the transition. The document from the NCS workshop (Appendix L) was an attempt to close the glaring gap between Natural Science in the GET phase and Physical Science in grade 10 (FET). However, it does not address all topics, for example Magnetism and Waves are not covered.

Therefore, being able to pass the CTA did not mean that a learner had sufficient scientific knowledge to cope with the demands of grade 10 Physical Science. The 2005 grade 9 cohort that followed C2005 was at a clear disadvantage compared to later groups (from 2006) who followed the revised curriculum that re-introduced content in the GET phase. The grade 9 science content required by the RNCS is given in Appendix L. The RNCS was already available to teachers in 2006, which means that the 2005 cohort were indeed in a unique situation, missing out on better preparation for grade 10 Physical Science.

As content was left almost entirely to the discretion of the teacher and the school in the GET phase (2005), the teacher in grade 10 Physical Science (2006) was left with the challenge of finding out which concepts had been dealt with and which had not been covered.

Table 5.1 The Common Tasks for Assessment: grade 9 Natural Science (2005)

Programme Organiser: Managing Malaria		
TASK	DESCRIPTION OF THE TASK	SKILLS
1	The classification of insects	
	The classification of insects 1 & 2	Observing; following instructions; using knowledge to classify; recording data
	The classification of insects 3 & 4	Observing; following instructions; using knowledge to classify; recording data
2	Malaria and the weather in South Africa	
	The occurrence of malaria in South Africa	Accessing information; reasoning
	Malaria in the infected provinces	Drawing a graph to present data
	Investigating findings regarding malaria cases	Formulating a question; identifying processes; making suggestions
3	The Anopheles Mosquito	
	The life cycle of the Anopheles mosquito	Applying knowledge in Life and Living; using information to inform actions; generating options; assessing impacts on the environment
	The male and female Anopheles mosquitoes	Applying knowledge
4	Malaria and its Control	
	Mosquito repellents – their atoms and molecules	Applying knowledge in Matter & Materials
	Mosquito repellents – the phases of matter	Applying knowledge; making decisions; justifying decisions
5	Malaria – a local solution	
	Good for who?	Appreciating indigenous knowledge; identifying impacts on the environment; identifying impacts on socio-economic development; making decisions
	Let's let everyone know!	Communicating information; promoting ideas
6	The sound of mosquitoes	
	Making sounds	Doing practical investigations
	The science of sound	Interpreting; applying knowledge in Energy & Change
	More science of sound	Gathering and selecting relevant information; calculating wavelength and frequency; identifying variables
	Hearing sound	Applying knowledge

Table 5.2 Analysis of the scope and depth of concepts covered in the 2005 CTA.

Matching with concepts in the 2005 Grade 9 exam (Curriculum 2005)	Concepts that should be understood in order to cope with grade 10 Physical Science (DoE, 2002(a))	Matching with grade 9 core knowledge and concepts (NCS)
Covered ← Covered Covered Covered	1. Waves <ul style="list-style-type: none"> • Rectilinear propagation • Reflection • Refraction 	Not covered Not covered Not covered Not covered
Not covered ← Not covered Not covered Not covered Not covered Not covered	2. Electricity <ul style="list-style-type: none"> • Charge (atomic structure) • Current • Potential Difference • Resistance • Series and parallel connections 	Covered Covered Covered Covered Covered Covered
Not covered ← Not covered Not covered Not covered	3. Heat and Work <ul style="list-style-type: none"> • Work, energy and power • Mechanical work ($W = F \times s$) • Particle model of matter 	Not covered Not covered Not covered Covered
Not covered ← Not covered Not covered Not covered Not covered	4. Magnetism <ul style="list-style-type: none"> • Magnetic and non-magnetic material • Polarity • Forces of attraction and repulsion • Magnetic field 	Not covered Not covered Not covered Not covered Not covered
Covered ← Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered	5. Chemical reactions <ul style="list-style-type: none"> • Atomic structure • Element • Molecule • Compound • Symbols and formulae • Metals and non-metals • Solubility • Mixtures • Solution • Combustion 	Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered Covered
Not covered ← Not covered	6. Acids and Bases <ul style="list-style-type: none"> • Reactions of acids with metals 	Covered Covered

5.3 CLASSROOM OBSERVATION

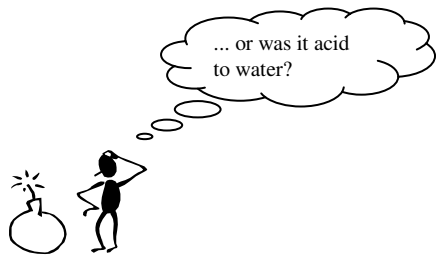


Figure 5.1 Poor teaching.

A total of 8 lessons (4 sets of twin lessons) were observed over four days. The first set of lessons (one each in the two grade 10 classes) was observed on the 15th of March 2006 and the rest on the 10th, 11th and 12th May 2006. By agreement with the teacher, I did not make a prior appointment for a particular lesson but instead showed up unannounced. This was to avoid having lessons specially prepared for the classroom observation. Table 5.3 gives an overview of the lessons observed.

In all the lessons observed, the teacher always stood in front. The sitting arrangement is represented in Figure 5.2. The learners sat in pairs on the desks that were arranged in rows. I was provided with a chair and sat as an unobtrusive observer in the last row of the class. The tape-recorder was placed in an open drawer of the teacher's table so that it would not distract the attention of learners. Two lessons on different topics were chosen for full transcription to best represent the problems that the learners encountered, both in terms of teaching strategies of the teacher and the learning style of learners. These two lessons were analysed according to general features of the lesson, questioning style of the teacher, classroom management, teacher directives/statements and the nature of learner engagement. These categories were used to focus on the description of the lessons and were adapted from the study by Manyatsi (1996).

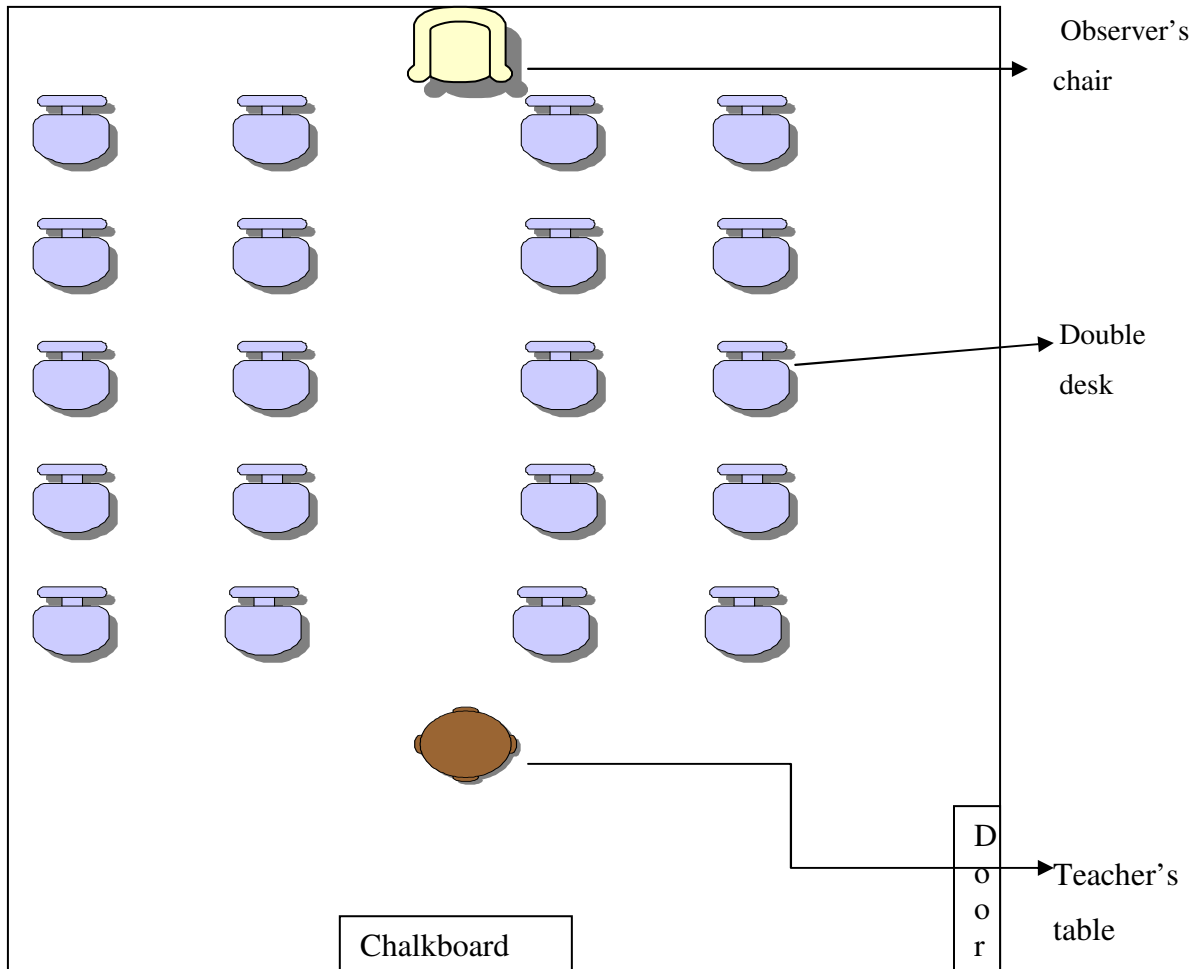


Figure 5.2 Sitting arrangement in the classroom (aerial view)

Appendix H and Appendix I show the full transcriptions of the two lessons. Those parts of the transcripts in parenthesis or italics are the researcher's insertions; either describing what could not be audio-taped or translating Sesotho into English in cases where the teacher was alternating between languages (i.e., alternating Sesotho and English in the lesson). Bold text denotes what the teacher either emphasized or wrote on the chalkboard. The lessons were coded numerically in the chronological order in which they were observed.

Table 5.3 Physical Science lessons observed

Lesson number	Date	Class	Lesson
1	15 March 2006	Grade 10A	Matter: mixtures – homogeneous and heterogeneous
2	15 March 2006	Grade 10B	Matter: mixtures – homogeneous and heterogeneous
3	10 May 2006	Grade 10A	Matter: elements, compounds
4	10 May 2006	Grade 10B	Matter: elements, compounds
5	11 May 2006	Grade 10A	Matter: atoms
6	11 May 2006	Grade 10B	Matter: atoms
7	12 May 2006	Grade 10A	Matter: metals and non-metals
8	12 May 2006	Grade 10B	Matter: metals and non-metals

5.3.1 Lesson 1 & Lesson 2

MATTER: mixtures – homogeneous and heterogeneous mixtures.

(i) General features:

The two grade 10 classes had an average of 40 learners each and the lessons took place in the classrooms. The teacher introduced the lesson by asking for the definition of matter. He went on to introduce the concepts elements, compounds, mixtures and suspension. It was a teacher-centred lesson in which the teacher did most of the talking. The only teaching aids used in the lesson were the chalk and chalkboard, on which the teacher jotted all the concepts discussed.

(ii) Questioning style:

The teacher asked oral questions from the beginning of the lesson to the end. These questions were mainly directed at the whole class and he rarely called learners by name to answer a question. The questions were classified into questions of recall, rhetoric and knowledge with understanding, with examples given below.

Recall: The teacher asked questions that required recall of facts i.e. memory questions.

Example:

Teacher: *Now, from previous classes I know that you have learned about what we call **matter**. What did we say **matter** was from previous classes?*

Student: *Matter is everything that occupies space and has mass.*

Rhetoric: The teacher asked leading questions that did not even need an answer.

Example:

Teacher: *Let's take examples of mixtures. Let's start with mixtures: If I take salt and mix it with water (writes on the board). I'm going to have a what? I am going to have a mixture! Not so?*

Students (in chorus): *Yes!*

Teacher: *And that mixture is called a clear mixture because water and salt can completely dissolve inside the what?*

Students (in chorus with the teacher): *Water!*

Knowledge with understanding:

There were questions that required knowledge with understanding.

Example:

Teacher: *Give me more examples of homogeneous mixtures that you see everyday.*

Student: *A coffee and hot water.*

(iii) Classroom management:

There was an occasion when there was dissatisfaction amongst learners after the teacher made what appeared to be an unconvincing argument.

Student: *In examples of homogeneous mixtures, do we always use water? Can you give an example without using water?*

Teacher: *Remember we have three phases of matter; it's either you can be able to mix liquid and solid or solid solid ... any example that will be able to be soluble ... that will combine completely ... remember homogeneous are those that can combine completely without eh ... in other words they are soluble ... they combine and they don't ... but homogeneous are those that cannot be separated easily ... yes my girl (diverting attention to another student who had just raised her hand).*

Student: *... how do you separate them?*

Teacher: *You can separate them through chemical means. Let's take an example of water and salt. If you heat the solution for a long time, the salt will remain inside the container.*

There were sustained hushed voices of dissatisfaction from the learners. Then there was a question from a student that was inaudible. The teacher ruled it irrelevant to the subject matter. He did not seem to be perturbed by the dissatisfaction and simply went on. The class became very noisy as they did class work. The teacher shouted at the top of his voice calling on the class to be quiet. It was after this reprimand that the class became quiet. He then went through the rows of desks to check on the learners' work.

(iv) Teacher's directives/statements:

The teacher gave both class work and homework to the learners:

Teacher: *Now; I have examples here; I want you together with your partner to separate them into homogeneous and heterogeneous.*

He wrote on the chalkboard: ink, milk, salt and water, tea, sand and water. The teacher then went around the class checking on learners as they went through the class work. The class was very rowdy. Towards the end of the period, he gave learners some homework: he asked them to look for five different products at home and identify their components from the labels, their % composition and then classify the components as solid, liquid or gas. Lastly they had to state if they were harmful or not. That was the end of the lesson.

(v) Nature of learner engagement:

There were no learner-initiated activities. Learners had to imagine the activities that the teacher spoke about: separation of mixtures (no practicals). According to Entwistle (1981), the learning style of learners affects and influences their response to different teaching styles. The difference between the teacher's teaching style and the learners' learning style leads to learning difficulties (Entwistle, 1981; Kempa & Ward, 1988). This ultimately leads to the learners not performing well when assessed (Manyatsi, 1996). This will also add to their transitional problems.

5.3.2 Lesson 7 & Lesson 8

MATTER: metals and non-metals.

(i) General features:

The two lessons took place in the classrooms. The teacher introduced the lesson by mentioning mercury as a metal. He went on to introduce the properties of metals and wrote them on the chalkboard. It was a teacher-centred lesson in which the teacher did most of the talking. The teaching aids used in the lesson were the Periodic Table, a sample of sodium, a sample of magnesium, chalk and chalkboard.

(ii) Questioning style:

The teacher only asked two oral questions throughout the lesson. These questions were mainly directed at the whole class and he never called learners by name to answer a question. Below is the classification of questions that the teacher asked:

Recall: The teacher asked questions that required recall of facts i.e. memory questions.

Example:

Teacher: *Sodium in conjunction with chloride gives us something that we use everyday. What do you think that is?*

Student: *Salt.*

Teacher: *We use gold – what do we use gold for?*

Student: *Jewellery.*

Open ended question:

There was an open ended question, namely:

Teacher: *... what is the fun of learning these particular metals everyday? (No answer from students)*

(iii) Classroom management:

At one point the teacher gave learners two samples of metals, namely sodium and magnesium. These were immersed in small containers of paraffin. As the learners waited

their turn to see the metals, the class became very rowdy and the teacher seemed to lose control. They only became silent when he spelt out what their homework was.

(iv) Teacher's directives/statements:

The teacher gave homework to the learners:

Teacher: *Now, while you are looking at that, I have written some of the names here of the elements. You are going to do your investigation now over the weekend. I want it on Monday. You do it on the exam paper; we are going to file it for your portfolio.*

You are going to investigate ... what is sodium hydrogen carbonate; you are going to look at which product contains sodium hydrogen carbonate and what you use that product for. There are six of those that you are going to look at.

(v) Nature of learner engagement:

There were no learner-initiated activities. Except for showing them the two metals, there was no hands-on activity in this theoretical lesson.

5.3.3 Summary

On the basis of the classroom observation tool in Appendix E (ELRC, 2003), I evaluated the teacher as follows (for both lessons 1 & 2 and 7 & 8):

Performance standard 1: Knowledge of curriculum and learning programmes

- He conveyed inaccurate and limited knowledge of the subject (e.g. boiling is a physical change not chemical).
- He displayed no skill of creating enjoyable learning experiences for learners (did not facilitate practical experience – no experiments or demonstrations).
- There was little or no evidence of goal-setting to achieve curriculum outcomes (he did not indicate the learning outcomes as prescribed in the NCS).
- He did make some attempt to interpret the learning programmes for the benefit of learners (he did teach the relevant content).

Performance standard 2: Lesson planning, preparation and presentation

- Lesson planning was not fully on a professional standard (he did not follow guidelines for lesson planning).
- Lesson was not presented clearly (learners had to imagine the activities that the teacher spoke about: separation of mixtures (no practicals)).
- Evidence of essential records of planning and learner progress was available (learner portfolios were kept).
- Learners were not involved in lessons in a way that supports their needs and development of their skills and knowledge (it was a teacher-centred discussion in which the teacher did most of the talking).

On a number of occasions, while listening to the teacher in class, I was tempted to stand up and correct him. But then I reminded myself that I had undertaken to be an unobtrusive observer. I also reminded myself of the ethics statement that I made, so I could not even report him to the principal. I had to sit throughout the lesson unable to intervene, which was a very uncomfortable experience!

The teacher did not follow the guidelines for lesson planning (refer to Appendix F). His lesson plans did not indicate the learning outcomes as prescribed in the NCS. He did not seem to be aware of new curriculum changes and approaches. Maybe it was the case of *The more things change, the more they remain the same* (*Plus ça change, plus c'est la même chose*) attributed to Alphonse Karr (1808 – 1890), French journalist, novelist. Les Guepes (Paris, Jan. 31, 1849) from <http://www.bartleby.com/66/88/32088.html> (retrieved 18 May 2006).

5.4 INTERVIEWS

To understand learners' problem solving strategies, eight of the Physical Science learners in grade 12 were selected to participate in semi-structured interviews following up on the diagnostic test they had just written. The learners were selected on the basis of performance in the grade 11 examination. The top four students in the grade 11 Physical Science examination were selected for interview and labelled as high achievers and the lowest scoring four students in the same grade 11 examination were selected and labelled as low achievers.

The learners were also categorized as post-positivist-oriented or empiricist-aligned based on their scores on the NOS survey; the mean was used as the cut-off point in the classification. The students selected on the basis of low examination achievement were those whose reference numbers (V_1 's) were 11, 13, 33 and 49 (refer to Table 4.13(a)). These four learners were also labelled as empiricists because of their low scores in the NOS questionnaire, and were all given pseudonyms that had initials of L.E. (Low achiever and Empiricist). For example, Lenah Edwards would be a girl who was a Low achiever and Empiricist-aligned. The high achievers (top four) according to Table 4.13(a) were those with reference numbers (V_1 's) 17, 18, 28 and 43, two of whom happened to be post-positivist oriented while the other two were empiricist-aligned. In this case the pseudonyms had initials of H.P. (High achiever and Post-positivist oriented) or as H.E (High achiever and Empiricist-aligned). For example, Hazel Planck would be a girl who was a High achiever and Post-positivist oriented while Humphrey Edwards would be a boy who was a High achiever and Empiricist-aligned. Table 5.4 gives details of scores and the pseudonyms used for the eight interviewees. The table shows the examination marks as percentages and the NSKS scores out of 240.

Table 5.4 Scores of the interviewees in the gr. 11 examination and the NOS questionnaire

V ₁	Gender	Exam marks (%)	NSKS score (max 240)	Pseudo-name
11	F	20	150	Lenah Edwards
13	F	24	159	Linda Epson
33	F	30	160	Louisa Ericsson
49	F	30	149	Liza Eddington
18	M	50	154	Henry Els
17	M	50	155	Humphrey Edwards
28	M	51	175	Howard Prins
43	F	60	167	Hazel Planck

Interviews were transcribed (Appendix J) and also coded to summarise responses. Table 5.5 shows the coding that was used to summarise the interviews.

Table 5.5 Response codes used for interviews.

Description	+1	0	-1
Physical Science is a favourite subject	Yes	Neutral	No
Career choice in the Physical Sciences	Yes	Neutral	No
Interest in the Physical Science increasing	Yes	Neutral	No
Teacher-student relationship is closer	Yes	Neutral	No
Teaching strategies meeting expectations	Yes	Neutral	No
Border crossing is smooth	Smooth	Managed	Hazardous
Avogadro's hypothesis	Conceptual understanding	Misconception/ Incomplete concept	No concept
Mole concept	Conceptual understanding	Misconception/ Incomplete concept	No concept

5.4.1 Sample interview

Table 5.6 traces a pilot interview with a student chosen randomly. He happened to be classified as a High achiever and Post-positivist oriented. The purpose of the pilot interview was to gauge the time it would take to interview one subject. The interviewee was named Herman Pattington. The interview took place on the same day that the rest of the interviews were conducted. The interview analysis using the above-mentioned coding is also given.

Table 5.6 Pilot interview with Herman Pattington

No	STATEMENT	Code
1	I: Good afternoon Ehm, what is your favourite subject in the FET phase?	
2	S: Is not only one, Life Sciences, Physical Sciences and Mathematics ...	
3	I: ... but what is your most favourite one, the one that you like most?	
4	S: I choose Maths, ... Mathematics	-1
5	I: Mathematics?	
6	S: Yes	
7	I: OK ... will you give me reasons why?	
8	S: I have always been good in Mathematics. Following my situation at home.... I have always been good at Maths ... It hasn't been that difficult.	
9	I: ... what career would you like to follow?	
10	S: I would like to pursue a career in actuarial sciences ...it deals with statistics and ... yeah	-1
11	I: Ok ...why would you choose actuarial sciences?	
12	S: 'cause, it mainly involves Mathematics of which is the subject I really like ... I feel like I will be able to do the job well.	
13	I: Ehm ...Is your interest in science declining, increasing or remaining the same as you move from the GET phase to the FET phase?	
14	S: OK, I think it is increasing, because in the GET phase, it was more on the general perspective, but then when you get to the FET it's a bit different, ... maybe you might say a bit harder but then ... it gives us more detail and ... I think it is increasing	+1
15	I: How do you compare your relationship with your science teachers in grades 7,8 and 9 with your relationship with your science teachers in grades 10,11 and 12?	
16	S: My science teachers in grades 7,8 and 9 ... eh ... I might say they were ... not really putting that much effort into teaching us ... there was like basics ... so I don't think it's the same as the ones in the FET phase but then ... there isn't much difference according to me.	0
17	I: Is the way science taught in the FET phase meeting your expectations ... is the way science taught in grades 10, 11 and 12 is that what you expected?	
18	S: No, it's not really what I expected. I expected it to be a bit more ... you might say ... specific and not like on a general ... like they are doing now	-1
19	I: In your own words, how do you describe the transition from the GET to the FET phase focusing on the transition from Natural Science to Physical Science?	
20	S: As I said ... eh ...Natural Science was a bit more broad, when we came to Physical Science and Biological Sciences/ Life Science, I think that ... my interest is more like in Life Sciences, so I see it as a change in which you see what better subject suits you best	0

No	STATEMENT	
21	I: Now we come to the diagnostic test that I gave you; the test was on the mole concept. In the first one I said to you “which one of these three sets best shows 1 mole of tin, 1 mole of magnesium and 1 mole of sulphur in each tube” and you chose set 1. Can you explain how you arrived at set 1. Why do you say set 1.	
22	S: If we are calculating for the molar value, we are using the volume of any element, so what I did was use the formula of $V = oh$, sorry, $n = V/V_m$ of which ... eh .. since set 1 has the same volume, eh ... the molar volume is 22.44dm^3 eh... I saw it as the same thing ... I arrived at the same conclusion.	0
23	I: In other words, when you see 1 mole of tin or 1mole of magnesium or 1 mole of sulphur, what comes to your mind is the volume ...(<i>interruption</i>)	
24	S: Not only that, but ... I think we have two ways of calculating the number of moles, which is the ... m/M_r ... so, since I do not have the exact figures of the mass of these two ... magnesium or sulphur, I could not arrive at the conclusion that my answer is correct or ...	0
25	I: Perhaps I should also ask you: what do you understand by a mole?	
26	S: A mole ... I think it is a value that is put in an element ... since elements are very small, so a mole is being used to ... as a relative number to give us some value of say a certain element.	
27	I: Thank you; let’s come to the second question: In the second question: you chose ... you said all of them ... all these containers contain one mole ...can you give reasons please!	
28	S: I said all containers contain one mole ... because when you use the formula $n = V/V_m$, I get one mole for all the containers ... since the volume of the containers is the same and the constant molar volume is the same, so I arrived at the same conclusion for all the containers	
29	I: Thank you!	

5.4.2 Favourite subject

A typical question that was asked was “What is your favourite subject in the FET phase” followed by “ will you give reasons why?”

It is interesting to note that seven of the eight interviewees did not choose Physical Science as their favourite subject. Three gave Life Sciences as a favourite subject and one gave Life Orientation as a favourite subject. Their responses were:

Liza Eddington: ... it has to be Life Science... because... eh ...my career... the career that I’m following has to do with the things that we are told in Life Sciences ... meaning that my career ... I want to be a doctor ... so I think that my career depends on it mostly

Linda Epson: My favourite subject in the FET phase is Life Science

Interviewer: Can you tell me why?

Linda Epson: Because in Life Science we learn more about human bodies ... it teaches us about things that we don't know.

Louisa Ericsson: Biology is kind of interesting to me ... I want to pursue a career that falls under Biology ... which is gynaecology ... because I'm more interested in knowing a woman's body; so, I do like Biology

Lena Edwards: Life Orientation

Interviewer: Explain why Life Orientation

Lena Edwards: It deals with exercising and I like to exercise

It is also interesting to note that all the low achievers have indicated Life Sciences and Life Orientation as favourite subjects. These subjects deal with everyday issues that are not abstract and do not require a high level of conceptual understanding. This could be the reason why low achievers prefer them over Physical Science and Mathematics.

Two interviewees preferred Mathematics to Physical Science. These learners were high achievers and cited passion as the reason for their preference as well as the fact that in Mathematics one does not have to memorize notes. Other factors such as poor teaching and lack of laboratory resources - as noted under classroom observation - could also have counted against Physical Science as a preferred subject:

Henry Els: It's Mathematics

Interviewer: Why Mathematics

Henry Els: Actually I have a passion for .. like playing with numbers and all that

Hazel Planck: My favourite subject is Mathematics because in Mathematics we do more with figures ... and you have to calculate ... it's not all about cramming the notes you are given ... you have to know your subject and you have to practice

In Chapter 4, I found that there was no correlation between interest and achievement in class. It is therefore not surprising that high achievers in Physical Science (Henry Els, Hazel Planck and Humphrey Edwards) named other subjects as their favourites. For example, the favourite subject for Humphrey Edwards was English:

Humphrey Edwards: It's English because... actually I like novels ... I like books much ... we get to do books and in those books we get life skills ... like for instance the book we are doing Maru – it takes you through a journey of somebody, then you get to learn such things.

Howard Prins was the only high achiever with a great interest in Physical Science:

Howard Prins: Science

Interviewer: Will you explain why science?

Howard Prins: Because ... in science ... I'm very good in science but again it's a subject that I found very interesting and which I wanted to pursue later on in future

In summary:

- Most learners did not choose Physical Science as their favourite subject, reasons ranging from simply being interested in their subjects of choice to lack of experiments in chemistry.
- The way one experiences transition from the GET phase to the FET phase can influence one's preference for the subject.
- It seems that there is a general lack of interest in Physical Science with the exception of one high achiever.

5.4.3 Career choice

A typical question asked was “What career would you like to follow?” followed by “Will you explain why?”

The responses were mostly in line with their favourite subjects. Again, the low achievers, indicated a career choice in the Life Sciences or community work (e.g. serving in the police):

Linda Epton: Metro police.

Interviewer: Can you give me the reason why?

Linda Epton: If you look at most people working in the Metro police, there are no females ... it's mainly males. I like the Metro police a lot because...it teaches people a lot: if you are a woman, you are a woman

Lena Edwards: I would like to follow nursing

Interviewer: Why would you like to follow nursing?

Lena Edwards: I like to deal with health problems ... I like to help sick people

Liza Eddington: ... it has to be Life Science... because... eh ...my career... the career that I'm following has to do with the things that we are told in Life Sciences ... meaning that my career ... I want to be a doctor ... so I think that my career depends on it mostly

Louisa Ericsson: Biology is kind of interesting to me ... I want to pursue a career that falls under Biology ... which is gynaecology ... because I'm more interested in knowing a woman's body; so, I do like Biology

All the high achievers chose careers in the hard sciences: engineering, computer and actuarial sciences. Both computer sciences and actuarial sciences need Mathematics as a prerequisite, that is a subject which both Henry and Hazel indicated to be their favourite.

Henry Els: I would like to follow computer sciences ... since I found that ...I have love for computers ...then I decided that ... let me rather choose a career which involves computers a lot.

Hazel Planck: I'd like to be an actuarial scientist, because as an actuarial scientist ... it deals with figures and statistics, and you also have to engage with the community; get to know more about the ... where the country is going in terms of its commercial/ financial status.

It was not surprising that Howard, whose favourite subject was Physical Science, chose mining engineering as a career.

Howard Prins: Mining engineering

Interviewer: Will you explain why mining engineering?

Howard Prins: Mining engineering is a very interesting field. In mining you deal with extraction of metals. The company which uses metals is the company that I want to work for ... I'm interested with working with the elements of the Periodic Table

Although Humphrey indicated English as his favourite subject, when he was asked about his attitude to science during transition, he did indicate that his interest in science was increasing as he was moving from the Natural Sciences to the Physical Science. It is therefore not surprising that he chose a career in the metallurgical science:

Humphrey Edwards: Metallurgical science ...in fact it's between metallurgical science and electrical science but I think I love metallurgy most.

In summary:

- The responses were mostly in line with their favourite subjects. Again, the low achievers whose favourite subject is Life Sciences indicated a career choice in the Life Sciences or community work (e.g. serving in the police).
- All the high achievers chose careers in the hard sciences: engineering, computer and actuarial sciences
- It seems that achievement in science does influence the career choice.

5.4.4 Attitude to science during transition

The typical question here was: “Is your interest in science declining, increasing or remaining the same as you moved from the GET phase to the FET phase”.

All the low achievers indicated a declining interest in science as they moved from the GET phase to the FET phase. It was disturbing to note that this trend was also seen amongst some

high achievers. The majority of learners were thus indicating a decline in interest. All the girls indicated a decline of interest and that includes the high achieving Hazel.

Lena Edwards: Decreasing ... because I see that when I came from primary school to secondary school, the primary school and the high school is not the same; at high school it is the place where you have to work hard and know what you want in life.

Louisa Ericsson: It is declining, because in ... what was the phase?... the GET phase ... it was more simpler than this phase I'm in now. I think it is also because what we did then is not the same as what we are presently doing because of the change in curriculum.

Linda Epton: No, it's decreasing, because in grade 9 it was better than this year, 'cause it's so difficult for me

Liza Eddington: Actually at the moment it is decreasing, but then I know that I will pull up again, but at the moment it is decreasing

Interviewer: What would you say is the reason?

Liza Eddington: I think that the things I was told before, were not that hard than now... things are changing and getting more difficult and I'm getting used to that... and the changing of teachers ... last year we were taught by teacher X now this year we are taught ... they have changed teachers, so I was used to teacher X from grade 10 and 11 but now they have changed him and so I think that is my problem.

Hazel Planck: My interest in science is declining because in the FET phase it's more complicated. I think the work is more and you have to memorise all these terms. It's more work and the chemistry part ... I like the chemistry part as I was doing grade 9 and grade 8 but as I got to grade 10 it was more difficult because there was a bit of change in the way it was taught and the way I understood it; and the other thing is that we don't have laboratory so we have to read the experiment from the text-book and cram it

Henry Els: It's declining

Interviewer: Can you give me reasons why?

Henry Els: Basically, from the GET section... the teachers there ... they were like ... trying to explain most of the stuff ... and we didn't like expect the way we are being taught now

An increase in interest was only found in boys. This was also in line with the statistical inference in Chapter 4 that there is a tendency to be more interested in Physical Science amongst boys as they moved from grade 9 to grade 10. It must be noted, however, that boys were a minority in the sample:

Humphrey Edwards: I think it is increasing because from grade 10 to grade 12 we were introduced into new things like for instance momentum and the rates of reactions ... you get to know how something happened that I did not understand how they occurred ... but now through science I understand why is it that all things go down and not up ... so I think being introduced to new things ... things that are related to everyday life ... I think it is increasing.

Howard Prins: It's increasing since I find it more interesting even though it's hard sometimes but I try to meet the standards of science.

Many studies on the subject of science have found that attitudes generally become less positive as students progress through the schooling system. Baurert (1995) used a longitudinal study of 9400 year 7 learners in Germany to confirm his assumption that interest in all school subjects declines as adolescents become more involved in developing a social identity. Studies in the USA and Australia, show that positive attitudes towards science decrease throughout the school years, with the most dramatic change occurring during the transition from primary to the secondary school system (Baird & Penna, 1992).

In summary:

- The majority of learners indicated a decline in interest as they moved from the GET science to the Physical Science in FET
- All the girls indicated a decline in interest in Physical Science as they moved from the GET to the FET phase
- Two boys (both high achievers) indicated an increase in interest.

5.4.5 Teacher-student relationship over the transition period

A typical question was: “How do you compare your relationship with your science teachers in grades 7, 8 and 9 with your relationship with your science teachers in grades 10, 11 and 12?”

There was a mixed reaction to this question. Some did not see any difference or did not categorise the relationship as close or distant:

Lena Edwards: I think they are the same, I don't see any difference

Louisa Ericsson: There is a difference ... the teachers in grade 10 were different and are not the same as the teacher I have now ... they have different teaching strategies

But the majority lamented the loss of a closer relationship with their teachers in the GET phase:

Liza Eddington: In grade 7 to 9 it was very good, it was very good because as I said before I was very good in those subjects but now it's good but not that good. It's not good because of what I've just said.

Henry Els: It's different ... because ...from the early grades .. teachers try to make us have more love for science rather than the ones we have right now. In the FET section, they come to class, teach you and the other work is for you to do

Howard Prins: Now the science teachers are a bit harsh about the work and in grade 7 grade 6, they were just teaching you everything, but now they tell you: the reason you are doing science is because you wanna be someone. So they teach you in such a way that you become interested more and more in science.

Humphrey Edwards: I think from grade 10 downwards, the relationship was kind of a parent and child .. because we were not .. they still took us as children .. . like they had to guide us ... talk to us ... understand us but since from grade 10 to grade 12

sometimes we were taught by an HOD ... he's got a lot of duties so actually he just comes to teach you ... you only have time to talk in class because they teach different classes and some are deputy principals they have to do some things ... so it's kind of a distant relationship

It seemed that most learners had closer relations with their GET teachers, similar to relations in primary school. The caring culture of the primary school has little in common with the more academically oriented, fragmented and competitive climate of the secondary school (Eyers, 1992). Similar problems are reported in Canada and the USA by Hargreaves and Earl (1994)

In summary:

- Most learners lament the loss of a closer teacher-student relationship in the GET phase
- A close teacher-student relationship would help to facilitate a smooth transition.

5.4.6 Teaching strategies over the transition period

The question was phrased as follows: “Is the way science taught in the FET phase meeting your expectations?”

The majority of learners expressed disappointment at the lack of opportunities to do experiments in senior grades:

Lenah Edwards: No.

Linda Epton: No. In grade 9 lessons were easier to follow, but in grades 10, 11 and 12 it's becoming more difficult.

Henry Els: No, it's not

Interviewer: Can you explain?

Henry Els: When you have to do certain parts, especially in chemistry ... that's where you have to do experiments .. so you find out that the school does not have enough material to help us out .. so you end up doing the experiment as part of theory.

Hazel Planck: No, it is not, because when I was in grade 8 and 9 we did a lot of experiments ... science was more of a practical subject but as we get to grade 10 we get stories like a ... things that we have to do like experiments ... they are expensive and we can no longer do them ...so science is now more like ...you have to cram and ... know terms by heart without actually seeing the things you are talking about.

Howard Prins: No it's not, because most of the time we only do theory and we don't normally use the labs, especially in chemistry for practical so you can understand more if you do practical but when you only do theory sometimes it's hard to understand.

The learners experienced disappointment similar to that reported by Baird et al., (1990), who noted the disappointment of learners who were beginning secondary school. The learners expressed their disappointment at the lack of activities, listening to lectures and the irrelevant topics (Baird, 1994).

In summary:

- Most learners indicated that the teacher's teaching strategies did not meet their expectations. They were hoping that to deal effectively with the challenges of the new environment (FET), they would be equipped with the necessary skills. They were disappointed to find that there were no chemistry experiments being conducted in the FET.

5.4.7 Transition – how they feel about it

A typical question here was: “In your own words, how do you describe the transition (movement) from the GET to the FET phase focusing on the transition from Natural Science to Physical Science?”

The majority of learners expressed the view that the transition was not smooth , but difficult:

Henry Els: I would say it's more like going to university but you're still at school ... in grade 9 we were told ... grade 9 is like grade 12... the way we are being assessed ...so... moving to grade 10 ... was more like you were doing your first year ... doing your first year in matric.

Liza Eddington: It's very different, it's very different, because... things are now changing and being more difficult because ... in grade 7, 8 and 9 things were simple then ... you were learning simple stuff and you would understand easily, but in grade 10, 11, 12 theirs were a bit difficult but then ... I think that's the way things should be, you know.

Hazel Planck: Well ... when you go to the FET phase ... there is more work ... it is more difficult. I think in the lower grades they prepared us for is change because we used to write assignments and we did a lot of essays - maybe about a page but when we get to FET we have to write about three pages or four pages ... it is more work ... but it is in a good way because in the GET we were prepared for that

Howard Prins :Natural Science was just basic things, something like general knowledge but now when you come to FET there are laws ... Newton's Laws and everything. Before you do anything in science you have to understand the concepts first. So, it's hard yeah, it's hard.

Humphrey Edwards: I think the transition was big, because the way I understand it, Natural Science was the combination of Biology and Physics so in the FET phase like this they put them into two. In Physics we use formulas and everything and in Natural Science we deal with things like volcano ... we focused more in the theoretical part. But now in the FET you have to know your theory together with your calculations and you get to be told new things that you didn't know, that you were not taught and some of the things are abandoned from grade 7 and in grade 10 you do new things.

Lena Edwards: In grade 9, 10, 11 is not the same as in grade 12 because in grade 12 ... I think that is the grade that is the most difficult. And we have to work hard so that you can achieve your dreams or goals

Louisa Ericsson: In Natural Science things were much simpler. Right now we do many things that we did not do in Natural Science.

Linda Epton: I think Physical Science is difficult

In summary:

Most learners felt that the transition from the GET phase to the FET phase was a difficult transition. Using the cross-border metaphor in the theoretical framework, one can describe the transition as hazardous (Cobern & Aikenhead, 1998).

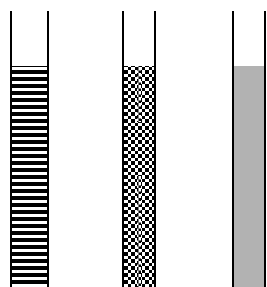
5.4.8 Conceptual understanding – learning strategies

The diagnostic test that was given to the subjects was meant to assess their conceptual understanding that was essential for negotiating transition. The interview question here was intended to help to answer research question 3: How can the learners' strategies and approaches for negotiating the transition be understood and explained?

The first question was asked as follows:

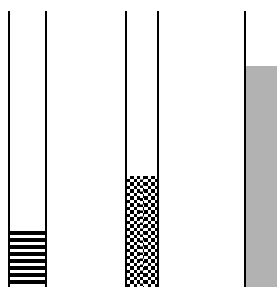
Which of these three sets best shows 1 mole of tin, 1 mole of magnesium and 1 mole of sulphur in each tube?

Set 1



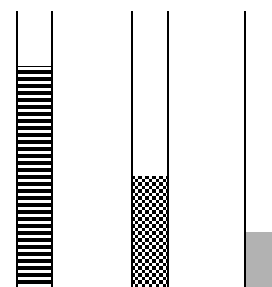
(a) (b) (c)

Set 2



(a) (b) (c)

Set 3



(a) (b) (c)

- (a) - tin
- (b) - magnesium
- (c) - sulphur

- key: Set 1 - equal volumes
- Set 2 - equal masses
- Set 3 - equal number of atoms

The interviewee was given his/her answer sheet to reflect on the answer and then asked to justify it.

Most learners chose set 1, probably because the textbook emphasizes that equal volumes of gases are a measure of equal numbers of particles, based on Avogadro's hypothesis. The students totally disregarded the fact that tin, magnesium and sulphur were all solids and simply applied Avogadro's hypothesis. Even a common solid like tin does not seem to give a clue:

Humphrey Edwards: I chose set 1 because ... first of all we are just given the number of moles which is 1 and we are not given the quantity of the volume so I decided to make the volume of each container to be 1, then I took the formula $n = V/V_r$ which is the S.T.P ... I took the volume of each container to be equal to that of the S.T.P then I used the formula $n = V/V_r$ which then I got 1... and because now the moles of tin, mole of magnesium and sulphur were each taken to be one ... so then I did one calculation and concluded that all of them in set 1 must be 1 because I assumed that ... the volume of each container must be equal to that of the S.T.P. That's the reason I chose set 1

Louisa Ericsson: I chose set 1 because I realised that the molecules were equal so I thought that they had 1 molecule

Of course this assumption is wrong as there are no gases involved here. Some said they have never even heard of Avogadro's hypothesis:

Interviewer: Have you ever heard of Avogadro's number?

Lenah Edwards: No

Interviewer: Have you ever heard of Avogadro's hypothesis?

Lenah Edwards: No

Liza Eddington: I chose set 2 because ... Mg is higher than S or Sn, their masses are equal but their volumes ... I thought they were not equal

Linda Epson: I chose set 2 because I saw .. eh.. equal volume, equal mass and equal number of atoms. Then I think it was the right answer.

Henry Els: Choosing set 2 ... I had confusion dealing with chemistry. ..if they are having equal masses ... then the number of moles must be equal ... rather than sticking to: if they have equal volumes ... equal volumes does not mean that they will always have equal number of moles ... because you may find that one may be a solid while the other one is a gas.

It was only the two high performing post positivist-oriented learners who chose the correct answer, namely set 3. They, however, did not give satisfactory motivation:

Hazel Planck: The reason why I chose set 3 ...I looked at the beakers in terms of the volumes ... the number of atoms which are in the beakers ... so I looked at the beakers and then I compared set 1,2 and 3 ... I looked at them in sequence ...in set one they are full and they decrease again in set 2 and set 3 again ... the beaker is still the same while the 3 beakers decreased

Howard Prins: Because in set 3 they said they are equal atoms – and the question said: in which of the containers had one mole so if ever the container has equal ... the

atoms are equal ... when they are about to bond ... it means there was one mole, one mole one mole in each before the reaction.

Interviewer: Before which reaction?

Howard Prins: It's tin, magnesium and sulphur, so in each of the sets they are ... ok, this one is one mole one mole one mole, if ever you are doing a reaction, let's say nitrogen and hydrogen then you use one mole one mole to give you the forward reaction

It was clear that learners had a serious problem with understanding the concept of the mole. The low achieving empiricist-aligned learners did not seem to have an idea at all. When asked what they understood by a mole, they responded as follows:

Liza Eddington: Actually nothing ... nothing

Linda Epson: I understand that a mole ... is something that ... they use it mostly in Physical Science ... maybe to describe ... I think sulphur, magnesium ... I think they are using chemical or electrical chemistry

The high achievers (both post positivist-oriented and empiricist-aligned) showed they had misconceptions or incomplete conceptions of the mole. They described a mole as either a number or amount (quantity):

Howard Prins: I think it's the number of atoms which are needed for a particular reaction to happen

Henry Els: It's a certain quantity of a substance ... whereby if you do an experiment ... you have to consider how much you put in. The other way of putting it ...it's like dealing with concentrations .. but ...by moles we deal with ... the quantity

Humphrey was the closest to describing the mole as a unit for amount of substance, but poor English got the better of him:

Humphrey Edwards: A mole is ...we calculate things in masses like for instance we've got kilograms, we've got grams and we've got milligrams but

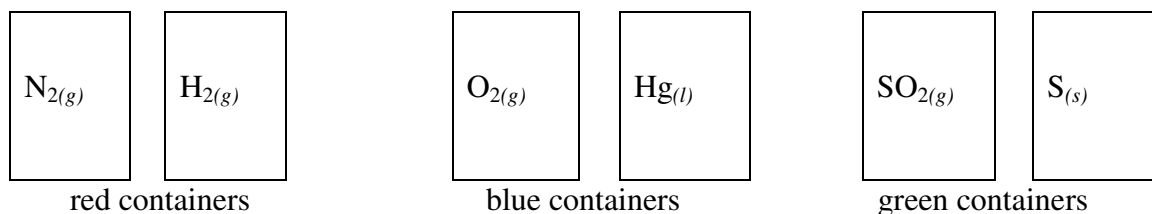
in science in most cases we experiment using smaller quantities ... we take grams and convert it to molar ... in a form of moles, so that it cannot be in that large number like kilograms

In the pilot interview, the interviewee (High achiever/Post-positivist) showed rote application of concepts and algorithms and described the mole in terms of volume. When he was asked to justify the choice of set 1 in the first question he responded as follows:

Herman Pattington: If we are calculating for the molar value, we are using the volume of any element, so what I did was use the formular of $V = oh$, sorry, $n = V/V_m$ of which ... eh .. since set 1 has the same volume, eh ... the molar volume is 22.44dm^3 eh... I saw it as the same thing ... I arrived at the same conclusion.

The next question was:

Each container represents a volume of 22,4l at S.T.P. In which of the three pairs of containers, if any, is there one mole in each container?



Learners were asked to give reasons for their choice as well as for not choosing others.

Once again, the subject was allowed to have a look into his/her answer sheet and asked to justify his/her answer. Some of those who correctly chose red containers provided incorrect motivation for their choice. The similarity in the number of atoms for each of the gas molecules in the red containers could have made it a plausible option for these empiricist-aligned subjects:

Liza Eddington: I chose red containers because I thought that the ... their volume, they were having the same volume

Interviewer: All of them have the same volume ... 22.4 dm^3 at S.T.P

Liza Eddington: Oh, yeah! ... I thought that ... because nitrogen has 2 ... 2 nitrogen and 2 hydrogen, so they will have 1 mole in each

Henry Els: I chose it (red containers) because ... when in class we were doing .. balancing the equations ... we were told that ... in front of an element ...the number in front represents ... the coefficient .. represents the number of moles.. then .. if nitrogen gas and hydrogen gas ... that would mean that ... they have equal number of moles ... meaning that ... each one has one compared to the other containers.

The high achieving post positivist-oriented Hazel was correct but indicated that she was not sure (showed 0% level of confidence) citing poor teaching or lack of teaching in chemistry as the reason.

Hazel Planck: I chose red containers because ... both elements are gases while in the blue containers you've got a liquid and you also have a solid (pointing to sulphur in the green containers). It's just because of the gases

Interviewer: I see that you have 0% level of confidence – are you sure that you are correct?

Hazel Planck: No, I am not sure that I'm correct – I just used common sense because here at school we are not actually taught ... chemistry we do a lot of the Physics part the calculations Not the chemistry part because it includes experiments

When asked why he said all containers had one mole of each substance, Herman Pattington a post positivist-oriented subject, replied as follows:

Herman Pattington: I said all containers contain one mole ... because when you use the formula $n = V/V_m$, I get one mole for all the containers ... since the volume of the containers is the same and the constant molar volume is the same, so I arrived at the same conclusion for all the containers

This is consistent with the misconception that Avogadro's hypothesis applies to all phases of matter. While the post positivist-aligned subjects seemed to labour under some misconceptions, the empiricist-oriented subjects had no conception of Avogadro's hypothesis as shown below:

Humphrey Edwards: I chose the green container ... I used the oxidation theorem ... I used the valency numbers ... I tried to find the oxidation number for oxygen in each container ... then I found the oxidation number of SO₂ to be 2,5 and then again I found the ... I found it to be 2,5 in both cases ... then I said it is the green container because the number of moles in each container is the same ... because the ratio of oxygen in each container is the same ... so I concluded that the number of moles is the same both in the ... due to the calculation that I have made.

Louisa Ericsson: Why I chose blue containers? Because both elements have a bigger number of mass ... they contain less number of atoms ... I was using a Periodic Table when I answered this question ... I found that one container had a gas and the other one consisted of a liquid. That's why.

Lenah Edwards: I was thinking that I added the red container with the green container, they will remain the same as the blue colour container

In summary:

- Faced with what seemed to be difficult conceptual problems, learners resorted to rote application of concepts and algorithms and sometimes guessing.
- They showed misconceptions and incomplete conceptions of the mole and Avogadro's hypothesis.

5.4.9 Summary of interview responses

Table 5.7 summarises the interview responses by all the eight interviewees. This table must be read in conjunction with Table 5.5 and Appendix J. The following list summarizes results the interview responses:

- Positive attitudes towards science declined during transition from GET (Natural Science) to FET (Physical Science).
- The negative attitudes towards science during transition seemed to affect career choices. Most learners chose careers outside the Physical Sciences.
- Lack of practical work, particularly in Chemistry, seemed to make learners less interested in Physical Science. Most of them did not choose Physical Science as their favourite subject.
- On the question of teacher-student relationships, the majority lamented the loss of a closer relationship with their Natural Science teachers in the GET phase.
- On the question of their expectations of teaching strategies the majority of learners expressed disappointment at the lack of opportunities to do experiments in the FET phase, particularly chemistry experiments in Physical Science.
- The majority of learners expressed the view that the transition was not smooth – in fact it was difficult. Using the cross-border metaphor, one can describe this transition as hazardous (Cobern & Aikenhead, 1998).
- Interviews confirmed a lack of conceptual understanding revealed by the diagnostic test. Learners' explanations indicated rote learning and algorithmic problem solving.

Table 5.7: Summary of interview responses

Description	Herman Pattington	Henry Els	Hazel Planck	Howard Prins	Humphrey Edwards	Louisa Ericsson	Lenah Edwards	Liza Eddington	Linda Epsom
Physical Science is a favourite subject	-1	-1	-1	+1	-1	-1	-1	-1	-1
Career choice in the Physical Sciences	-1	-1	-1	+1	+1	-1	-1	-1	-1
Interest in the Physical Science increasing	+1	-1	-1	+1	+1	-1	-1	-1	-1
Teacher-student relationship is closer	0	-1	+1	-1	-1	0	0	-1	+1
Teaching strategies meeting expectations	-1	-1	-1	-1	+1	+1	-1	+1	-1
Border crossing is smooth	0	-1	-1	-1	-1	-1	-1	-1	-1
Avogadro's hypothesis	0	0	+1	-1	-1	-1	-1	-1	-1
Mole concept	0	0	-1	0	0	-1	-1	-1	-1

5.5 CHAPTER SUMMARY

Document analysis

In 2005 when learners in this study were in grade 9, content was left to the discretion of the teacher and the school. The 2005 grade 9 CTA for Natural Science did not test content needed for the 2006 grade 10 Physical Science. Learners could have had huge gaps of knowledge while passing the grade 9 examination. Curriculum 2005, therefore, did not adequately prepare learners for grade 10 Physical Science.

Classroom Observation

The teacher seemed to be unaware of new curriculum developments. There was little or no evidence of goal-setting to achieve curriculum outcomes. He focused on lesson objectives only and used a teacher-centred approach even in cases that lent themselves to learner-centred activities. His limited knowledge had serious implications for the extent to which the learners were exposed to the processes of investigation pursued by South Africa's learner-centred education policies. The teacher demonstrated no skill of making learning enjoyable and thus contributed to the decline in interest by the learners.

Interviews (8 learners)

In general, one can say that positive attitudes towards science decline during transition from GET (Natural Science) to FET (Physical Science). Six of the eight interviewees, all of them empiricist, indicated a decrease in interest in Physical Science and chose careers that did not involve Physical Science. Only three learners, all high achieving boys, two of them post-positivists, indicated an increase in interest in Physical Science.

Some learners lamented the loss of a closer relationship with their Natural Science teachers in the GET phase and most of them expressed disappointment at the lack of opportunities to do experiments in the FET phase, particularly chemistry experiments in Physical Science. They ascribed their poor conceptual understanding to the lack of practical work.

The transition was difficult for the majority of learners – they resorted to rote learning and cramming. They demonstrated misconceptions and incomplete or no understanding of the mole concept and Avogadro's hypothesis. Using the cross-border metaphor, one can describe this transition as hazardous (Cobern & Aikenhead, 1998).