A Case Study of Input and Classroom Interaction in a Multilingual Chemistry Class at the Port Elizabeth Technikon

Thesis

Submitted in partial fulfilment
of the requirements for the Degree of

Master of Education
of Rhodes University

by

SALLY POTGIETER

January 1996

REPORT ON THE THESIS PRESENTED BY
MRS SALLY POTGIETER FOR THE DEGREE OF
MASTER OF EDUCATION

I enjoyed reading this work, and I believe the candidate has isolated several non-trivial features of her subject's teaching/lecturing style. I believe she ought to be awarded the degree subject to her making the changes indicated below to the satisfaction of the Head of Department.

p.5: the comments from "In my thesis..." to the end of the chapter should be grouped under a separate sub-heading such as "Conventions used", etc.

p.6: the use of the term "social practice" is not adequately prepared for. The paragraph needs to be expanded by 1/2 sentences to explain more clearly what is meant by "both of these are entirely mediated by social practice".

p.7: sort out inverted commas in the quotation from Taylor et al.

I do not accept the equation that is made in the second paragraph of 2.2.1 between "institutional discourse" and "academic literacy". Surely academic literacy is the ability to participate fully and profitably in the discourse (or multiple discourses) of a particular academic institution?

p.9: references to "DET schools" should be updated to "ex-DET" throughout, in compliance with national usage. Moreover, although the meaning of "DET" is given in full in a table, it should be glossed in its first use in the text.

p.10: the statement "English is centrally located in education in this country today" betrays a rather superficial view of the current status of English. The candidate should at least note that the status of English is a hotly contested "site of struggle": its location is far from securely established from a political perspective.

p.11: the words "kinds of" need to be inserted after "The two" in the fourth sentence of the paragraph beginning "To explain how...". As it stands, the statement does not make sense.

p.12: I would like the word "official" inserted before "medium of instruction" in sentence two of the paragraph beginning "However...". This has a nuance which the candidate herself employs on p.103 where she says "English has ostensibly been..." The point here is that there is a good deal of informal evidence to suggest that, despite the "official" situation, African languages are widely used as MOI right up to Matric in many ex-DET schools.

p.14: last two lines: "which in itself is a scientific concept". I don't see how a language can be a "scientific concept". Is "construct" intended?

p.16: replace "He" with "Bond" at the beginning of the last paragraph on the page.

p.18: heading: delete "S" from "CALPS". Change "Cummins made" to "Cummins makes" and provide a date for the reference.

pp.18-20: although the candidate acknowledges the "arguments against BICS and CALP", I don't believe she has worked through them fully enough. One reference to Luckett is not really adequate. I personally find the distinction important and useful but one must be aware that the academic and political cards are quite heavily stacked against the distinction attaining the usefulness it deserves in the "medium debates" in this country.

pp.21,24: 3 instances of the use of "also" in a sentence-initial position as a logical connector. I find this usage stylistically weak and overly colloquial for academic discourse. "Moreover" or "In addition" are to be preferred.

p.22: the paragraph beginning "Linguistically Krashen's...". The summary is too condensed and leads to a number of illogicalities (see comment on p.6 above). It needs to be reworked and more clearly argued.

p.27: the syntax of the sentence beginning "Long claims" is hard to follow and needs to be disentangled.

p.28: the date of Wong Fillmore's study is here given as 1983, whereas everywhere else it is 1985.

p.30: the Lanham-Rodseth debate is inadequately documented. Neither name appears in the Bibliography. Who or what is the source for this very important point?

p.34: Walker and Adelman: this reference does not appear in the Bibliography.

p.36: "in a multilingual class" - a "hidden" generalisation? Surely the candidate should confine herself to her particular classes?

p.37: "interpretive/interpretative" - iron out the inconsistency.

p.41: delete the ? from the sentence beginning "The question this poses..."

p.43: 3.5.1 the phrase "a relatively new phenomenon at the P.E. Technikon" should be in parentheses.

p.64: "Swains" should read Swain's and be dated.

p.73: the comment beginning "The reluctance of those..." should be couched more tentatively and more clearly linked with the supporting evidence that follows.

p.77: line 7 "orbitl" misspelt.

p.78: "illustrated" should read "illustrates" and "reinformed" in line 7 should read "reinforced".

p.102: the reference to "Brookes" should read "Brookes and Brookes".

p.105: the parentheses around the Waggoner reference need attention.

The revisions are relatively minor in most cases. There is nothing which suggests that the degree should not be awarded, but there is a lack of "critical edge" in both the theoretical and the write-up parts of the work which suggests that a distinction would not be appropriate.

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Report on M.Ed thesis submitted by Sally Potgieter

The thesis considers the role of input and classroom interaction in a multilingual chemistry class with a view to making some comment on the usefulness of this aspect of the lecture situation to promote better understanding on the part of the chemistry students. The study has resulted in some interesting outcomes which I think could help to give other lecturers important tools to promoting understanding of the concepts on the part of their own students.

The greatest strength of this thesis lies in the meticulous care with which the case-study was presented. A great deal of careful thought and planning was used in developing and collecting the data required for this research. I was particularly impressed with the concern the researcher shows for all the individuals involved in the research, and the way in which she has been able to use the enthusiasm of the lecturer concerned. At the same time she has ensured a high level of confidentiality and given to all concerned in the interviews the opportunity to reflect positively on the lecture situation. The data has been very clearly presented, and I found it very easy to use.

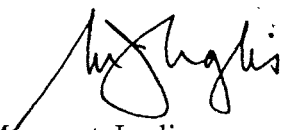
The analysis of the data focused mainly on the types of strategies used by the lecturer in the lecture situation. This was systematic and thorough. However, analysis of other aspects of the data (for example, discussion of the students' comments), would I believe have enhanced the study. In addition I felt that the data analysis avoided any explicit return to the broader theoretical framework.

The theoretical background tries to cover too much ground in too superficial a manner. This is a vast area and one that is problematic to delimit. I think a more satisfactory strategy would have been to focus more strongly on the Second Language Acquisition framework on input and locate that within a background of issues of language and cognition, rather than try to deal with so many ideas in such a short work. As a result, the researcher makes too many assumptions on the part of the reader. For example, on page 10, there is a passing reference to Piaget and on page 13 there is a passing reference to Bakhtin's ventriloquation. These references, with no further explanatory comment, serve to confuse the reader, rather than illuminate the ongoing discussion. A discussion of Vygotsky's ideas cannot include reference to other relevant theorists without a similar explanation of their theories. A serious omission, however, is the absence of at least fifteen references used in Chapter 2 and Chapter 3 in the Reference List at the end of the thesis,

as well as the omission of page numbers in the in-text referencing.

The layout and presentation of the work is clear and easy to follow. The use of clear headings and ample spacing has been greatly appreciated.

I consider that this thesis should be awarded a mark of 70%.



Margaret Inglis
External Examiner

20 February 1996

ABSTRACT

This study examines input and interactional modifications in a multilingual chemistry class at the Port Elizabeth Technikon.

The investigation constituted observing lectures presented in chemistry and analysing the data so obtained within a framework developed from a study of current theories on the relationship between language and cognition and the role of input. It was further informed by data gathered from interviews with the lecturer, questionnaires administered to the students and separate focus group discussions with first language and second language speakers of English.

The conclusion is that the lecturer's interactional and input modifications make the subject content accessible to both first language and second language learners. I have made suggestions for future research in this area in the belief that the data gathered in this case study offers some useful pointers for the retraining of teachers of multilingual classes in a tertiary context.

ACKNOWLEDGEMENTS

I am very grateful to Sarah Murray who has played several roles in my life over the past two years, as supervisor, mentor, and friend, and I feel privileged to have been associated with her.

My studies have been enhanced by a special group of fellow students, and an equally special band of colleagues and friends who have provided assistance and re-assurance.

I am indebted to Ms Leonie Potgieter, lecturer in Chemistry at the P E Technikon, for her willingness to be part of this study and for her unfailing cheerfulness and encouragement.

I thank my husband and son, Flip and Andrew, who have encouraged me to pursue my professional career and postgraduate studies despite the heavy demands made on my time and energy.

Special mention must be made of my brother-in-law and sister and family, Gareth and Judy Cornwell, who have given me support in so many ways and provided a home from home for me in Grahamstown.

Grateful appreciation also goes to the CSD and the P E Technikon for financial assistance.

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CHAPTER ONE

INTRODUCTION

1.1 Aims of the research

This study looks at input and classroom interaction in a multilingual chemistry class at the Port Elizabeth Technikon in order to gain a better understanding of:

- The ways in which the first year students in this multilingual classroom comprehend the lecture input.

- The ways in which a subject lecturer makes input and interactional modifications in a multilingual class.

- What input and interactional modifications are effective in catering to the language and learning needs of all students, but particularly second language learners.

1.2 Origins and context of the research

The Port Elizabeth Technikon has in recent years positioned itself as a non-racial, non-sexist democratic institution and has pro-actively provided access for students from disadvantaged academic backgrounds. As a result, the demographics of the student population at the P E Technikon have changed dramatically since 1988. This has led to an ever-growing number of students studying through the medium of English which is frequently their second, third or even fourth language. For convenience in this thesis I will use the term "second language speakers" to refer to all students who do not have English as a first language. Students in this

category have varying degrees of proficiency in English.

The growing number of non-native speakers of English at the P E Technikon raises the issue of how this institution can adjust to meet the needs of these students. There is a great deal of concern about academic achievement at the P E Technikon. In a management report Uys (1993) showed that of the students enrolled in 1990, only 26% completed their studies in three years.

The main problem seems to be in the first year enrolment where only 36% of all full-time students (all faculties) pass all their subjects (Uys, 1993).

The success rate of school leavers from the different education departments is shown in Table 1.

Education Department	% Passing
House of Assembly	46%
House of Representatives	32%
House of Delegates	33%
Department of Education and Training (DET)	17%

Table 1: Students passing all their subjects in their first year.

With the increasing enrolment of black students, who are all second language learners (L2 learners), at the P E Technikon, the overall success rate is likely to drop alarmingly (Sharwood 1994).

As a result of its concern, the rectorate has set up a working committee to investigate and identify possible causes, and to formulate an admissions and support policy for the P E Technikon. I have been elected to serve on the committee in my capacity as English Second Language Co-ordinator. During the meetings of this committee a number of issues have been discussed and pivotal to these discussions is the vital role that language has to play in learning. Recognized as problematic is the fact that the

situation described above is a new one for most of the lecturers, who do not have the experience or training to deal with classes where a sizeable majority are non-native speakers (NNS) of English, and who find it difficult to make the necessary adjustments quickly.

There are two possible ways to help non-native speakers understand lectures in a second language (L2). One is to improve their knowledge and skills in the target language until the comprehension process is no longer a problem. The other more realistic way in a tertiary environment is somehow to modify the form of the lectures, to vary the input, so as to make it easier to comprehend.

As part of the course work component of my MEd, I carried out a preliminary study to investigate the quality of input (defined by Ellis (1990) as the formal adjustments that teachers make to their speech when talking to L2 learners) and interaction (defined by Ellis (1990) as the discourse jointly constructed by the learner and his interlocutors) in a multilingual Communication in English class. The results suggested that few adjustments in input or interaction were being made to accommodate the L2 learner (Potgieter, 1994).

In the course of my work as lecturer in English Communication and English Second Language Co-ordinator, I meet with lecturers in other subjects. In discussion concerning the problems that L2 learners were experiencing in content subjects where the medium of instruction is English, reference was made to Miss Potgieter, who is a lecturer in Chemistry and is very concerned about the achievement of the L2 learners in her classes. Mention was also made of the creative way in which she presents her subject and the adjustments she has made to meet the needs of the L2 learners in her classes. In November 1994 I asked Miss Potgieter to participate in my research project, which would involve observing 5 lectures presented in chemistry and analysing the data within a framework

developed from a study of current theories on the relationship between language and cognition and the role of input, and she willingly agreed. Perhaps this willingness was influenced by the fact that she is a second language speaker of English herself and by the fact that she is very interested in issues relating to medium of instruction.

It is hoped that my interpretation of the data in this research project will generate ideas for future research and will be of use in raising the consciousness of lecturers across the curriculum of the nature of input and classroom interaction in a multilingual classroom, and the implications of this for their own teaching.

1.3 Structure of the thesis

This thesis examines classroom interaction in a multilingual chemistry class in order to gain a clearer understanding of how adjustments in input and interaction have a bearing on the quality of learning in that subject.

In Chapter 2 the literature is reviewed in order to establish a framework within which to examine the data.

In Chapter 3 the research theory and methods for a case study are discussed. Problems and methods of the data collection process are described in detail because the reliability of case study research depends on careful documentation of procedures (Yin 1984). In keeping with the principles of democratic research, a draft copy of this research report was given to the lecturer involved in this study for her comment and approval. This was done in an attempt to work for and with the lecturer rather than on her (Cameron et al. 1993). A draft of the description and analysis has been discussed with the lecturer and her comments are included in the Appendix section (Appendix K).

In Chapter 4 the data is analysed according to the theoretical framework described in Chapter 2. The framework for the discussion was drawn predominantly from Huizenga's characteristics of effective input and the Vygotskian view of cognitive development and the construction of knowledge.

Chapter 5 includes comments on the research findings, a comment on the researcher's response to case study research, and a discussion of some of the pedagogical implications of the research findings for the multilingual tertiary context.

1.4 Conventions used

In my thesis I have used the lecturer's name, Ms Potgieter, shortened at times to Ms P for convenience' sake. This decision was reached after consultation with Ms Potgieter, for two reasons: first, Ms Potgieter was quite happy to have her name used and saw no need for anonymity. Second, because this research project was a collaborative effort I felt that a pseudonym might diminish the major role Ms Potgieter played and would not reflect the nature of the relationship that evolved during the case study.

In this thesis I refer to myself, the researcher, in the first person. I have done this in the interests of honesty and integrity because I believe that ethnographic research is interpretive and subjective by nature.

I have used the female pronoun "she" in instances where the gender of the referent is neither specified nor relevant, in symbolic redress of the inequity of past and current linguistic practice. English has no neutral pronouns and I wanted to avoid using "he/she" which can be rather clumsy. However, I have not changed the gender in direct quotes.

When using quotes from the lecturer and students I have kept to the original words of the speakers and have not indicated errata in the belief that "sic" used in this context is not only irritating but patronising.

CHAPTER TWO

THEORETICAL BACKGROUND

2.1 Introduction

This chapter aims to describe the dual problem for English second language (ESL) undergraduate students in mainstream courses at the Port Elizabeth Technikon of having to develop L2 competence and academic competence at one and the same time. Kress (1985) acknowledges that the more abstract forms of learning (typically found in the tertiary context) are increasingly dependent upon language to be constituted, sustained and communicated; with language come the conceptual frameworks that order knowing and both of these are entirely mediated by social practice. Krashen's (1985) position endorses this view as he believes the best way of developing L2 competence is through subject or discipline-specific content.

First, I will broadly contextualise the issues of literacy and learning, and learning and language. Secondly, I will focus particularly on the notion of input, and the notion of interaction, as I see these two notions as the key to understanding the relationship between linguistic and cognitive competence.

Benson (1989) in Flowerdew (1994: 181) calls the lecture "the central ritual of the culture of learning", and it is the input from lectures that is the primary source of content information in tertiary settings. Failure to comprehend that input can have disastrous effects on the ability of the student to perform academically. Flowerdew (1994: 20) believes that there are two possible ways to help non-native speakers understand lectures in a second language. One is to improve their knowledge and skills in the

target language until the comprehension process is no longer a problem, a facility which unfortunately is not offered to L2 learners at the Port Elizabeth Technikon. A lack of competence in English is often perceived by students and lecturers as the primary cause of the failure to understand input; however, lecturers typically do not see this deficiency as part of their responsibilitiy. As a lecturer in Law puts it: "We have enough to do without teaching basic English to students, especially first year students".

The other approach is somehow to change the input, that is, to modify the form of the lectures so as to make them easier to comprehend. Adopting this second and, in the circumstances, considerably more pragmatic approach, this research will look into the nature of input and interaction variables in chemistry lectures at the Port Elizabeth Technikon, and students' responses to these.

2.2 Literacy and learning

2.2.1 Defining academic literacy

As access to our technikon has been broadened, the cultural context has changed dramatically. "Lecturers can no longer assume a generally shared culture amongst students, or that learning can rise up from a uniformly literate intellectual landscape" (Taylor et al. 1988: 4). At the P.E. Technikon, an historically white institution, the Western intellectual tradition still holds sway, and this implies that learners from alternative traditions must be the ones to make the difficult transition.

Like other tertiary institutions, the technikon has developed its own institutional discourse, which encompasses the values and practices of a particular academic culture and ways of seeing, thinking, knowing and speaking that are both a part and product of these practices. The institutional discourse is sometimes referred to as academic literacy, where the term literacy refers not simply to the ability to read and write, but to the social practices in which it is embedded.

The notion of academic literacy entails an understanding of multiple literacies. According to Gee, we all acquire a primary Discourse: "our socio-culturally determined ways of thinking, feeling, valuing and using our native language to focus in face to face communication with intimates which we achieve in our initial socialisation within the 'family' as this is defined within a given culture" (Gee 1990: 171). Academic literacy, on the other hand, is a secondary Discourse - rational, decontextualised and impersonal - which is realised, in the case of L2 learners, through a language other than that of their primary Discourse (Murray 1994).

Thus students have to learn the discourse and the culture of their academic institution, but as Ballard and Clanchy point out, they also have to learn the discourse of a number of different "sub-cultures" in the institution - the sub-cultures of the particular disciplines they have chosen, for example Chemistry or Economics.

Bond (1993) argues that because it is crucial in an institution's construction of culture, meaning and knowledge, language needs to be accorded a central place in tertiary work: "Language not in the sense of formulaic grammar, but as a 'flexible instrument' which students learn to utilize alongside the study of all other disciplines" (p 143).

It seems then that the key to advancing student literacy lies in identifying the linguistic and cognitive codes of a discipline and making these explicit to students. However, Ballard and Clanchy (1988) suggest that it might be difficult for academics to objectify their own academic culture because the assumptions of their discipline have become internalised.

In his response to the Ballard and Clanchy paper, Bond (1993) puts forward another reason for the failure of academics to make the culture of the discipline explicit and he gives an idea of why the process of "acculturation"

is more complex than it may at first seem. He says that in the university context we cannot

> ... assume the existence of a clear terrain waiting to be revealed for more effective student travel. In fact, it is often the case that some of the underlying assumptions of disciplines are themselves the site of contestation between academics; hence the avoidance of explicit statements of such in introductory level courses. The result is often the obfuscating vagueness which reinforces the challenge facing new learners (Bond 1993: 144).

2.3 Language and cognition

2.3.1 Vygotsky

The complex inter-relationship of language and cognition can cause problems for 'new' students at the technikon. The students are 'new' in the sense that there is often a mismatch between their set of experiences and what the technikon in general demands as its "standards of success". They are 'new' also as many of them are the first generation of their family to experience tertiary education. Many of these students could be termed disadvantaged in that they are studying through the medium of their second or third language and, having attended ex-Department of Education and Training (DET) schools, are now faced with having to acquire an academic discourse which has virtually no connection with their primary Discourse.

Discussing the inter-relationship between language and cognition, Vygotsky (1987) takes the position that language is a vehicle for learning, that modes and patterns of linguistic use are social processes, and that language simultaneously shapes and reflects experience from the earliest stages of childhood development. Thus his ideas have great relevance for all teachers

in South Africa, and particularly for English language teachers because English is centrally located in education in this country today.

Vygotsky also believed that all higher thought functions are mediated processes, and the central part of the mediated process is the word. Each concept (and each word) is a generalisation. At every stage of learning, new generalisations, through mediation, are built upon preceding ones, and the new, higher concepts change the meaning of the lower ones. In his words: "Thought is not expressed, but completed in the word" (1978: 250).

Vygotsky's notion of the Zone of Proximal Development (ZPD) adds another dimension to meaningful learning. The ZPD is the difference between the learner's actual level of development (in the Piagetian sense) of independent problem-solving, and the level of performance which she achieves in collaboration with other more capable adults or peers. Vygotsky puts it as follows:

> The actual development level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively. (1978: 87)

What this means for the teacher, is that actual development is towed by instruction, or other forms of mediation, not the other way round. We do not have to wait until a learner has reached a certain level before aiming what we teach at that level. Vygotsky states it simply: "The teacher must orient his work not on yesterday's development in the child but on tomorrow's" (1987: 211).

Vygotsky argued that a child's concept formation is a slow and gradual process which is facilitated by social interaction with peers as well as teachers. He believed that it is this process that forms individual

consciousness and higher mental functioning and that the process occurs during formal education (Britton 1987). Bruner (1986) agrees with this when he states that:

> I have come increasingly to recognise that most learning in most settings is a communal activity, a sharing of the culture. It is not just that the child must make his knowledge his own, but that he must make it his own in a community of those who share his sense of belonging to a culture. It is this that leads me to emphasize not only discovery and invention but the importance of negotiating and sharing, in a word, of joint culture, creating as an object of schooling and as an appropriate step en route to becoming a member of the adult society in which one lives out one's life. (Bruner in Britton 1987: 25)

To explain how a child makes knowledge "his own", Vygotsky distinguished between schooled (scientific) and everyday (spontaneous) concepts. Spontaneous concepts are those that are acquired unconsciously from everyday life. Scientific concepts are those that are learned formally through education and are therefore consciously learned. The two kinds of concepts are interdependent as scientific concepts can only be learned if they are based initially on everyday concepts. In this way everyday concepts mediate the learning of scientific concepts as learning proceeds from the known to the unknown. Everyday concepts, on the other hand, benefit from the link to scientific concepts because they are opened to a whole new realm of meaning: abstraction and generality. The development of higher mental processes is the bringing together of these two concepts (from concrete to abstract and abstract to concrete) because it is this union that forms what Vygotsky called "true concepts" (Vygotsky 1978).

One must keep in mind that the theory being developed in the early

"Vygotskian" classroom was a theory of development in the learner's mother tongue. What then, were Vygotsky's views about second language acquisition (SLA)? He viewed foreign language learning as schooled, conscious learning to be taught in a disembedded manner. He also stated in *Thought and Language* (1978) that the teaching of a foreign language should be more concerned with the new language's external manifestations than with semantic aspects, since meaning systems have already been constructed by learners in the acquisition of their first language. He also believed that children might not be able to learn a foreign language unless they have what is considered to be a degree of maturity in their first language.

However, the context described in this study is not a "foreign language context" as envisaged by Vygotsky. The students are not learning English as a foreign language; it is the official medium of instruction in ex-DET schools from std 3 and at the P E Technikon in all subjects. Also, it is the dominant language in society, so L2 learners have a pressing need to learn English for a wide range of social, educational, pragmatic and heuristic functions. In tertiary education they are going to have to do much more with English than mere translation into it from their mother tongue. They are going to have to move into "deep" language acquisition, which implies that they have to think and conceptualise through this second language so that they do not use it in a studied, conscious way, but in a spontaneous way.

Bakhtin's ideas for a sociocultural approach to mind relate to Vygotsky's. His analyses of utterance, voice, social speech type, and dialogue suggest new ways to extend the notion of semiotic mediation, while retaining the basic advantages of a Vygotskian approach. Of particular importance is that Bakhtin's analyses focus on forms of discourse that allow the investigator to make a concrete link between institutional, historical and cultural factors on the one hand and the mental functioning of the individual

on the other. For Wertsch (1991), Bakhtin's process of ventriloquation is fundamental to development; referring to the ways in which Vygotsky's ideas changed towards the end of his life, Wertsch says:

> ... his position shifted toward the view that mastery of scientific concepts is fundamentally linked with participation in discourse of a particular type, namely instructional discourse in classrooms. (p.131)

Ballard and Clanchy (1988: 17) in discussing academic literacy endorse this view by stating that achieving cognitive competence in a discipline cannot be divorced from achieving linguistic competence in that discipline - "the language informs the knowledge; the knowledge finds its form and meaning within the language". This leads to the difficulty of determining whether the source of students' problems is linguistic or cognitive, or even to the question of whether this is a sensible distinction to make. In this regard Ballard and Clanchy cite examples to indicate ways in which a student's language can be judged highly effective and competent in one discipline and yet incorrect when faced with complex ideas, or ineffectual when unaware of the distinguishing characteristics of an alternative academic discipline.

Jiya (1993: 84), in a study of the language difficulties of black BSc students at the University of Fort Hare, argues for the importance of intervening at the point of cognitive interaction in order to encourage the appropriate use of language, and warns Academic Support Programmes to look beyond language proficiency in order to improve the performance of ESL students. Jiya's research suggests that ESL students' difficulties stem not so much from the language itself, but from using language as a tool for the gathering, formulating, ordering and sequencing of ideas.

In discussing the problems of ESL Science students, Inglis and Grayson (1993) ask us to consider that the apparent lack of proficiency in English on a particular task may be indicative of one or more of the following:

- poor ability in English that prevents adequate achievement of the task;
- poor understanding of the demands of the task;
- misconceptions about the concepts that the task is designed to test;
- misunderstanding or lack of knowledge of underlying concepts that the task concepts are based upon.

Each of these levels of concern may represent difficult challenges to some ESL learners.

Perhaps Hanne Bock's image (in Taylor et al. 1988: 81) best sums up the relationship between language and knowledge:

> as interlocking spirals up which a learner moves unevenly; at points where the language and cognition intersect the learner is capable of articulation of the knowledge. Sometimes learners have the vocabulary but lack understanding of the concepts; but sometimes the concept is grasped intuitively while the vocabulary is inadequate to express it.

Often a neglect in dealing with the language needs of L2 learners has led to a situation which can be explained in Vygotskian terms. The scientific skills and concepts which most need "schooling" are treated as spontaneous skills. If a content subject is learnt in the first language, the pupil can use her stock of everyday concepts to mediate the unfamiliar scientific concept. But if pupils learn a subject through a second language which is in itself a scientific concept, this will lead to a confusing chain of mediation where the

content subject is mediated through the second language which then has to be mediated again through the everyday concept of the first language (Lenahan 1992).

What are the pedagogical implications of Vygotsky's theories for the lecturer? The role of the lecturer becomes a very important and pro-active one, as it is the lecturer who shares the responsibility of interacting socially with the student and has to, in Vygotsky's terms, open up for the learner the ZPD and provide assisted performance for its realisation. Assistance may take the form of lecturer/student interaction, or peer tutoring or group activity. Thus the lecturer needs to make the classroom a rich, interactive learning community.

Vygotsky highlighted the importance of everyday activities and content in providing meaning, the "conceptual fabric" for the development of schooled concepts. To make learning significant one must go beyond the classroom walls, beyond empty verbalisms; "schooled" knowledge grows into the analysis of the everyday, in other words, living knowledge enters the classroom.

Lecturers need to be aware that the emphasis in lessons should not be on transmitting knowledge or skills that would be internalised in the form transmitted; the emphasis should be on joint literacy activities mediated by the teacher intended to help learners obtain and express meaning in ways that would enable them to make this knowledge and meaning their own. In such a teaching system within these zones of proximal development, learners develop what Bruner (1986: 130) calls "reflective intervention" in the knowledge encountered: the ability to select knowledge as needed.

This perspective is consistent with what Vygotsky (1987) felt was the essential characteristic of instruction: the introduction of conscious

awareness into many domains of activity, i.e. learners acquire control and mastery of psychological processes through the manipulation of tools of thinking such as reading and writing. As Bruner (1986: 132) has put it: "it is this 'loan of consciousness' that gets children through the ZPD".

Bond (1993) sounds a cautionary note when he points out that we should retain a critical perspective on all attempts to transform education in South Africa. He states that those who find much to guide them in Vygotsky's perspective on mediated learning, for example, do not always see the inconsistencies in his approach. He argues that Vygotsky's Marxist orientation enabled him to place considerable emphasis on social and environmental factors in language development, and to expound a persuasive dialectic of language and learning. Similarly, his model of the ZPD serves as an effective guide to pedagogy and course design. Nevertheless, because he draws on the linguistic and cognitive development of children, his model is one of acculturation - an acceptance of the culture (or academic literacy in the case of tertiary institutions) to be learnt - which is decidedly unrevolutionary in its approach. As Aronowitz and Giroux (1991) would argue, to adopt this framework is no more than a case of "progressives" making room for the excluded in the established culture.

Bond concedes, however, that at this juncture in SA, perhaps broadening institutional and epistemic access and success is in itself a transformatory process. Maybe the international power of the hegemonic academic literacies is so strong that they offer greater rewards to their students than any possible national transformation. However, we need to problematize our attempts to develop academic literacy if we are to have a clear sense of what we mean by educational transformation in the South African tertiary context.

Genre theorists such as Cope and Kalantzis (1993) criticise educational ideas put forward by theorists such as Aronowitz and Giroux. They, together with Delpit (1988), draw on Vygotsky and Bakhtin and argue against progressivist notions such as "process writing" which emphasize individual creativity and "difference" because they believe that they simply further disadvantage those who are marginalised. The genre theorists, in general, make a plea for explicit teaching of powerful genres of writing, because without this, the control of these genres remains available only to those who are "born" to them by virtue of the social milieus in which they live.

To conclude this section I want to discuss Vygotsky's ideas on play as I feel they have relevance to concept development, imagination and literacy. In *Mind in Society* (1978) Vygotsky uses the example of the young child pretend-playing to illustrate the onset of the imagination as a new transformative mental process. In seeing the roots of imagination in something so universal and ordinary as young children's play, Vygotsky seems to be saying that this highly valued mental quality is basic, is in all of us from very early on, and is the foundation-stone of our development as thinkers. Certainly play, like language, is a universal human activity which we practise and learn through right from the start. Vygotsky goes on to make great claims for play, observing that during it children are "above their daily behaviour", and "beyond their age in development". In other words, play creates a zone of proximal development for the child, or for that matter, student.

Too often in schools and in tertiary environments, Vygotsky's paradox, which he calls "a rule that has become a desire" simply becomes a rule. So the line of descent which Vygotsky describes for us, the onset of imagination beginning in pretend-play, and leading on to literacy, and thence to the higher mental operations, gets broken.

2.3.2 BICS and CALP

Starfield (1994: 177) argues that Cummins' theory of the role of language in learning clarifies the relationship between language and cognition and also explains why students coming from a DET background are not prepared for the tasks which face them at tertiary institutions.

Cummins made a distinction between what he called Basic Interpersonal Communication Skills (BICS), that is, the "spontaneous" language used in conversation and informal contexts, and Cognitive/Academic Language Proficiency (CALP) which is the "schooled" language necessary for higher cognitive functioning. He also made a distinction between context-embedded and context-reduced communication (see Figure 2.4.1 below). The BICS/CALP framework proposes that language proficiency can be conceptualized along two continua. The first continuum relates to the amount of contextual support available when expressing or understanding meaning. On the one extreme is context-embedded communication where the language is supported by contextual cues and participants can actively negotiate meaning by indicating, for example, whether or not the message has been received. This communication draws on BICS. On the other extreme is context-reduced communication, which is based almost exclusively on linguistic cues to meaning, with very little or no contextual support. This communication draws on CALP.

The second continuum relates to the degree of active cognitive involvement in the task. Cummins and Swain (1986) conceptualise cognitive involvement as the amount of information that must be processed simultaneously or in close succession by the individual involved in the task. The more cognitive involvement demanded, the more CALP will be used.

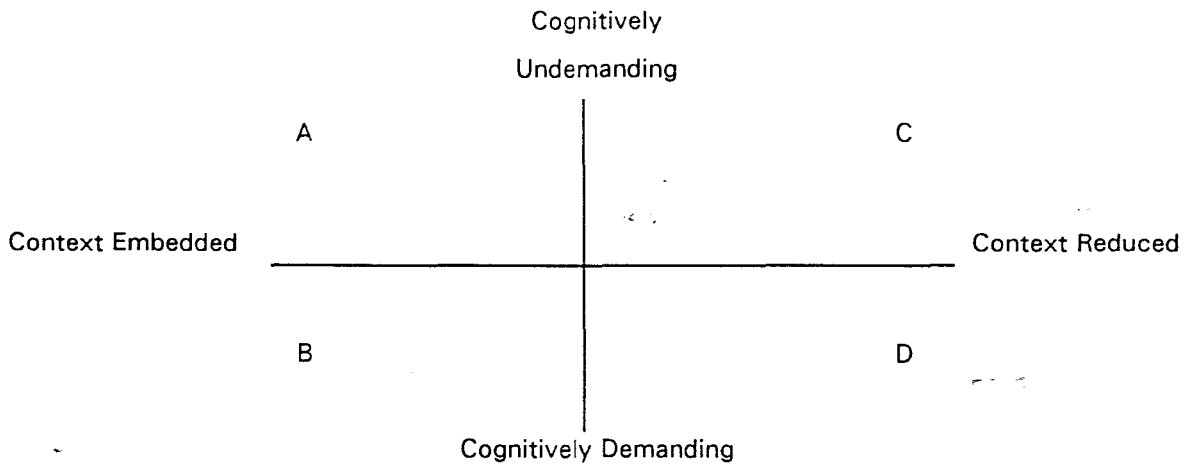


Figure 2.3.1 Range of Contextual Support and Degree of Cognitive Involvement in Communicative Activities

In contexts where the medium of instruction is a second language the development of CALP can be retarded, as it can only be developed once BICS have been acquired in the second language.

The distinction between BICS and CALP was expressed in terms of the "iceberg" metaphor adapted from Roger Shuy (1978, 1981) (See figure 2.3.2 below).

Figure 2.3.2 Surface and Deeper Levels of Language Proficiency

Shuy's analysis elaborates on some of the linguistic realizations of the BICS/CALP distinction. The major points, he believes, embodied in the BICS/CALP distinction are that some heretofore neglected aspects of

language proficiency (e.g. semantic and functional meaning) are considerably more relevant for students' cognitive and academic progress than are the surface manifestations of proficiency (e.g. pronunciation, basic vocabulary) frequently focused on by educators who fail to appreciate that these differences can have particularly unfortunate consequences for L2 learners.

Starfield (1994: 177) relates this to the South African context. She argues that in the DET schools, academic literacy (CALP) is never really acquired in the first language, due to the change in medium of instruction in Standard 3. CALP then has to be acquired in the second language, but in reality, because of limited English proficiency and difficult content, pupils are forced to rote learn and CALP is never sufficiently developed. A first year student agreed with this when participating in a focus group discussion: "At school I was taught to memorize but here [in Chemistry] I have to think and understand".

The arguments against BICS and CALP are acknowledged. The distinction between them can set up notions of deficit and CALP tends to be viewed as having concrete reality "when in fact it is a culturally specific set of school-based discourses and cognitive abilities" (Luckett 1993b: 21).

However, as Luckett points out, the notions of BICS and CALP provide a useful model in helping us to understand the demands made on students' language and the language competencies that they need to develop. Also, the decontextualised language that Cummins has identified as CALP is valued in modern society, and to exclude students from access to this society, by not acknowledging the existence of CALP, would be to perpetuate the inequities of the past.

2.4 The role of input

The above discussion raises the question of how lecturers, specifically through their lecture input, can assist their students in acquiring the necessary CALP to cope in an academic (i.e. a context-reduced) environment. How can they encourage both linguistic and conceptual development?

For the purposes of this discussion, input will refer to the language which is used to convey concepts and to provide cognitive stimulus. Corder (1986) developed this idea by isolating the notion of "intake", i.e. that portion of the input that the learner actually attends to and therefore uses for acquisition. Not all input serves as intake.

The concept of input used will be drawn mostly from theories of second language acquisition. Bearing in mind the integral relationship between language development and concept development, I will draw on relevant aspects of SLA theory and relate it to the broader language and learning context.

At the P.E. Technikon approximately 42% of the students registered in 1995 are non-native speakers of English. The medium of instruction (MOI) at this institution is English, and therefore the quality of input is of critical relevance for these students. In a context such as this, Ellis (1990) believes that whether it is a subject lesson or a content lesson successful outcomes may depend on the type of language used by the teacher and the type of interactions occurring in the classroom.

Wong Fillmore (1985) argues that the language used by teachers serves both as a means of imparting information and skills and as the linguistic input on which students can base their learning of English as a second language. Moreover the teacher's language often serves as the only regular oral exposure that many ESL speakers get to the target language.

Thus we need to consider what would be considered effective input for L2 learners in a subject classroom at the P.E. Technikon, where the L2 learner is placed in a class with students who are native speakers of English. I will draw from two sources for my discussion, Huizenga (1990) and Wong Fillmore (1985). While I have delineated the characteristics of input for the purpose of my discussion, in reality they are interlinked and do not always separate as we might like them to.

2.4.1 Comprehensibility

A common complaint voiced by lecturers at the P.E. Technikon is that no matter how slowly they lecture, or how carefully they adapt the vocabulary they use, students still do not understand the content of their lecture. Schema theory, largely developed in the field of reading but applicable to any input, states that meaning is constructed through the interaction of input and the existing background knowledge of the individual (Carrell 1988). This interaction of new information with old knowledge is what is meant by the term comprehension.

Without lecturers first assessing the extent of their students' prior knowledge, much new input will not be successfully internalized. More specifically, if students do not have the necessary background knowledge, the lecturer must provide it, otherwise students will be unable to comprehend a lot of what is said in the lecture.

Linguistically Krashen's input hypothesis is relevant here. This accounts for how learners' interlanguage develops as a result of comprehending input that contains linguistic features one step beyond their current knowledge (i + 1). I cannot subscribe to Krashen's (1985) view that comprehensible input is sufficient for language acquisition to take place. Such a view neglects the crucial contribution of the learner, not only in processing the

input, but in producing language which in turn affects the follow-up in an interaction (Ellis 1990: 91). The learner's involvement in shaping the interaction, and the negotiation of meaning which takes place in any interaction, are essential for achieving communicative competence. This response to Krashen's input hypothesis has been termed the interaction hypothesis.

2.4.2 Negotiation of meaning/ Interaction

Huizenga also highlights the importance of negotiation of meaning. She states that if learners can comment on the input they receive, ask questions, ask for clarification or repetition, they can have some control over the input and can thus influence their intake. Swain in Ellis (1985: 122) sees this kind of obligatory rewording in order to maintain communication as one of the reasons why output is an important part of SLA. This reinforces Allwright's (1991) view that only the learner can do the learning necessary to improve performance and it is the effort made by the learner to comprehend the input that fosters development.

Wong Fillmore (1985) in her article on "the characteristics of teacher-talk that work as input" extends the notion of negotiation of meaning by discussing the tailoring of elicitation questions to allow for different levels of participation from students. I believe that this discussion has particular relevance for lecturers at the P.E. Technikon. She believes that questions which elicit or require one word answers provide very little practice for the learner. Open-ended questions, however, call for a higher level of control over the structures, forms and usages of the language that learners may have, especially at early stages of learning. Thus the lecturer should try to tailor questions to fit the proficiency of individual students. Most importantly students who are not proficient in English should not be ignored. Also the more reticent student can be included through questions, allowing sufficient waiting time for them to answer.

According to Wong Fillmore, through questions the teacher can advocate clear and fair turn allocation procedures for student participation with lots of turns for each student and a variety of responses invited or elicited, which should facilitate successful language learning. Also through questions the teacher can focus the students' attention on what they are saying rather than on how they are saying it. At the same time, however, teachers should try to repeat the one word or short response supplied by the students and expand them into full sentences by way of confirming their responses.

Questions can pose difficulties from the students' point of view since those who raise a query find themselves in an exposed, public position. "Asking a question requires such an effort that, having got it out, the questioner is too emotionally drained to pay attention to the answer" (Shaw and Bailey 1990: 325 in Flowerdew 1994). Question askers also run the risk of being considered (in white South African culture) stupid, attention-seekers or creeps and so it is understandable that the ambiguous "Are there any questions?" at the end of a lecture is so routinely ineffective that it has come to mean "That's all for today".

Also, although questions offer one way for students to clear up doubts and comprehension problems, we often see that there are complications. As mentioned earlier, students can be reluctant to venture questions, and often lecturers discourage questions as they may fear dislocation of the lecture. Again, many L2 learners feel that their asking a question might imply a slight on the lecturer's authority, and a reluctance to ask questions is often compounded by language difficulties.

Ideally, then, the lecturer should pause after asking questions to allow listeners the time to review what they have just heard and to formulate

questions. Also they should avoid the need to bid for a turn during the flow of a lecture. Such pauses provide a clearly signalled space for clarification requests and might go a long way towards helping L2 students to take the initiative in asking the questions they need to ask.

Another way to overcome a reluctance to ask questions is for the lecturer to spell out early on in the course the preferred ground rules for questioning in her subject.

2.4.3 Contextualisation

This leads to Huizenga's next point which is contextualisation. She states that the richer the extra-linguistic context, the easier the learner will find it to comprehend the input: a point which takes us back to Cummins (See 2.3.2). Krashen describes two ways in which comprehension of input containing new linguistic material is achieved: firstly through the utilization of context by the learner, and secondly through the provision of simplified input by the teacher. Thus the learner can make use of context to infer the meaning of an utterance when existing linguistic resources are insufficient for immediate decoding.

In the classroom, context can be provided in a number of ways: by talking to learners about the here and now - that is, about what is in the immediate classroom environment; by using gesture and motion to accompany input; by showing relevant pictures or realia along with the input, or by using video. Non-visual ways of providing context might be to give or elicit background information before students listen to something.

A common problem experienced by ESL students is misunderstanding words which have different meanings in different contexts, one everyday conversational meaning and one discipline-specific meaning. For example,

words like "force", "weight" and "energy" in science do not have the same meaning as these words used in everyday conversations (Jiya 1990). If lecturers do not predict difficulties beforehand and make this difference in meaning clear, students will not internalise the "disciplinary dialect" (Ballard and Clanchy).

Wong Fillmore adds that if teachers put new information in the context of work students have already completed, they make it possible for them to make use of prior knowledge and experience as a context for making sense of the new material. Thus lecturers need to interact with students so as to access the foreground knowledge of the student and should never assume that all students possess the same knowledge. Contextualising the knowledge which students need to acquire within the knowledge they already have will make it far easier for the students to acquire the new knowledge presented to them and to form 'true concepts' in the Vygotskian sense.

2.4.4 Modification

A fourth characteristic identified by Huizenga is modification. She claims that input that is modified or adjusted in some way to accommodate learners, will help understanding.

Classroom research studies show that teachers engage in a kind of "foreigner talk" with their students, which differs from the way they speak with native speakers. They may use expansions, repetitions, or paraphrase; they may simplify their vocabulary; they may articulate more carefully than normal. Wesche and Ready (1983) looked at professors in various fields in an American University. Each professor was teaching one section of a course to native speakers of English and one to non-natives. The researchers discovered that all the professors adjusted their speech for the

non-native groups, although they all had very different ways of doing this.

Do these adjustments actually help students? Long (1983) says yes. He conducted a study in which he scripted and recorded two lectures. Each had the same propositional content, but one was designed for native speakers while the other was filled with modifications typical of foreigner talk. Long then took students in the same general proficiency range, assigned them to one lecture or the other, and tested everyone's comprehension. He found that subjects hearing the modified version seemed to understand more than did those hearing the native-speaker version. Long claims that because he found a causal relationship between foreigner talk and comprehensibility, and if one considers Krashen's hypothesis that there is a causal link between comprehensible input and second language acquisition, then one can deduce an indirect causal relationship between foreigner talk adjustments and second language acquisition.

But the situation might not be as clear cut as this, especially in the context of a content classroom involving L1 and L2 learners. Although modified input is advocated, how much modification is too much, and how appropriate are the modifications for the L1 learners in the class?

2.4.5 Communication

A fifth characteristic identified by Huizenga is communication, whereby she states that language must be meaningful in that real content must be conveyed.

Cummins (1986) quotes from Long (1983) and Wong Fillmore (1985) in making his point that using English as a medium of instruction, where real content is conveyed, works much better than teaching English as an isolated subject. Not only does the amount of comprehensible input

increase, but the formal properties of the language are connected with communicative functions, a connection which makes the language learnable. What Cummins is recommending, then, is not having subjects in school called "English" but rather "Math in English" or "Photography in English" and so on; a recommendation also made by Krashen.

2.4.6 Authenticity

Huizenga believes in authenticity as an important aspect of input and claims that language needs to be realistic so as not to distort input. She also maintains that the content should be engaging, interesting, relevant material which will hold the learner's attention.

2.4.7 Repetition and predictability

The characteristics of repetition and predictability identified by Huizenga as acting as successful input are endorsed by Wong Fillmore's study (1985) in which she suggests that for young learners at least, clear lesson boundaries and consistent, repetitive acts free learners from always having to guess at what is coming next and where it fits in with what has gone before.

2.4.8 Affect

The final characteristic is that of a positive affective environment. Huizenga states that anxiety, lack of self-confidence, motivation or other affective variables can influence how much input is converted to intake.

It was primarily due to Krashen's Affective Filter Hypothesis (1982) that U.S. language teachers began to consider seriously the role that affect plays in learning. Krashen claims that if the filter is high, that is, if students are anxious, lack self confidence or feel threatened, then not much input will

get through to them, no matter how good the input might be in other respects.

Huizenga, however, states that to her knowledge, there is no research which actually establishes a correlation between affect and intake.

O'Neill (1991) argues that when we think of teacher-talk we must not only consider the choice and appropriateness of structure and vocabulary, but even the way teachers use their voice and bodies to give an extra, affective dimension to the words they speak.

He adds that as a result of the emphasis on student-centred lessons, these skills are ignored or even decried. They are under deep suspicion because some think of them as appropriate to actors rather than teachers. He believes that they are essential skills. Good teachers who have these skills, he claims, do not behave in class like bad actors. They use such skills modestly and at the right time to promote learning, not egocentrically to enhance their own image or to monopolize the limelight.

He endorses this by stating that it is too often forgotten that good teaching involves basic physical as well as cognitive skills, or more accurately, skills which require both cognitive elements and physical training to perform economically and effectively.

O'Neill makes this point about language teachers who are traditionally more prepared to use their "voice and bodies to give an extra affective dimension to the words they speak". A teacher of chemistry, however, might find this more difficult as she might feel that this does not go with the discipline of science teaching which is traditionally perceived as logical, rational and cognitive, and thus very often affective features are ignored and overlooked.

2.4.9 Code-switching

Wong Fillmore (1985) argues that teacher talk that works as input clearly separates languages and that there should be no alternation or mixing between the L1 and L2. This view might be supported by a comment from a student in response to the questionnaire which was distributed as part of this study:

> My school teachers have a tendency of not complying with the medium of instruction which is English. They frequently use the Xhosa words to clarify certain points which harmed me in one way because I'll end up knowing something in Xhosa and fail to put it in English. But here at the Technikon I am expected to do everything in English.

Very often in a content lesson lecturers allow the students to form groups and to use their mother tongue so as to understand a concept, and then it is translated into English. They have found this to be a very useful teaching tool and they believe that it gives the students confidence and acknowledges the multilingual nature of the class. Thus they would not support Wong Fillmore's point of view because they believe they are more concerned with the development of "content" knowledge.

Prof. L. Lanham (1995) in a personal communication to Vic Rodseth presents a forceful argument against the type of code-switching practised by these lecturers. He takes issue with Rodseth on a central theme in the approach in START (Strategies for Academic Reading and Thinking) Reading Level I (a course designed to develop reading and study skills across the curriculum). Rodseth states that in this course "multilingualism is well catered for as students, learning co-operatively, can code-switch as they prepare to transform text for an English-only presentation. Allowing the mother tongue encourages concept formation and clarity .... "

Lanham believes that this approach utilises translation as someone has to

translate what has been expressed in the mother tongue. This requires a translator with a considerable degree of linguistic competence in English and the mother tongue. It also requires the ability to recognise the extent and the limits of semantic overlap between English and mother tongue translation equivalences, and more importantly, any conceptual blanks that may exist between the two languages.

He argues that concept formation of the English word/s should be acquired through experience of applying the word/s in physical and linguistic contexts which delimit the concept.

He concedes that mother tongue could be used in a single brief explanation, as a time-saver to facilitate clarity, but it should only be used one way: teacher to pupil.

I acknowledge the argument that code-switching can have an inhibiting effect on achieving proficiency in the target language and that this issue requires further debate. However, my experience has revealed that allowing students the option to choose either their mother tongue or L2 to assemble ideas and opinions allows them access to a greater range of expression than confining them to their L2. Also it creates an atmosphere of linguistic tolerance in the classroom and can lower the affective filter for many L2 learners who often feel strange and alienated in an unfamiliar environment.

Van Lier (1988) states: "every teacher in a multilingual class is at least a part-time L2 teacher". He believes that teachers need to be responsive to the needs of students, create an atmosphere where diversity is respected and valued, and through the instruction of their subject create rich opportunities for language input and output in both speaking and writing.

2.5 Summary

This chapter has attempted to show the relationship between language and learning and special attention has been given to the South African context. Because this thesis focuses on the role of input in a multilingual chemistry classroom the second part of the chapter has discussed those characteristics of input and interaction which would be applicable to this situation.

CHAPTER THREE

RESEARCH OUTLINE AND METHODS

3.1 Introduction

3.1.1 Research Outline

This chapter will begin with an explanation of the goals of the research. This will be followed by a discussion of the research theory applicable to this study, a justification for the use of the single case study using interpretive methods, a further justification on the grounds of reliability, validity and generalisability, and a discussion of ethical issues. Next will follow a description of the research process: the reasons for the choice of the lecturer under observation, the setting up of the research and the equipment used. Multiple sources of evidence were used in the collection of data for this study and these are described in full. Case study research is complex and seldom free of problems and I have outlined some problem areas that emerged during the research process.

3.1.2 Goals of research

This study looks at input and classroom interaction in a multilingual chemistry class at the Port Elizabeth Technikon in order to gain a better understanding of:

- The ways in which the first year students in this multilingual classroom comprehend the lecture input.

- The ways in which a subject lecturer makes input and interactional modifications in a multilingual class.

- What input and interactional modifications are effective in catering to the language and learning needs of all students, but particularly second language learners.

3.2 Research Methods

In attempting to analyse input and interaction in a multilingual content classroom, I decided to focus my classroom observation on one lecturer. The rest of this chapter will discuss the nature of a single case study and attempt to justify the use of qualitative, interpretive methods and naturalistic enquiry for gaining insight into classroom practice.

3.3 Case study Research

Merriam (1988: 16) has defined the qualitative case study as an intensive, holistic description and analysis of a single entity, phenomenon, or social unit. Case studies are particularistic, descriptive and heuristic, and rely heavily on inductive reasoning in handling multiple data sources.

Walker and Adelman (1976: 72) suggest that there are six principal advantages of adopting the case study as a method of research:

- The first advantage is that in contrast with other research methods it is strong in reality and therefore likely to appeal to practitioners, who will be able to identify with the issues and concerns raised.
- They claim that one can generalise from a case either about an instance, or from an instance to a class. (I shall consider this particular claim in the next section when I look at the issues of reliability and validity).

- A third strength of the case study is that it can represent a multiplicity of viewpoints, and can offer support to alternative interpretations.
- Also, properly presented case studies can provide a data base of materials which may be re-interpreted by future researchers.
- The insights yielded by case studies can be put to immediate use for a variety of purposes, including staff development, intra-institutional feedback, formative evaluation and educational policy-making.
- Finally, case study data are usually more accessible than conventional research reports, and therefore capable of serving multiple audiences.

The case study in this research is classroom based. There are two broad types of classroom based research. Firstly, there is systematic observation (McIntyre and Macleod 1986) which considers "micro-action" using a systematic set of classifications for recording classroom events. It falls into the positivist paradigm of research methods because its analysis is based on quantitative data, it describes overt behaviour, and it pays little heed to the context in which the observed lessons take place. The second approach to classroom observation uses ethnographic techniques in an interpretive paradigm. The purpose is to gain an understanding, not only of the overt behaviour, but also of the reasons behind such behaviour. The strength of this kind of research is that it moves away from "the simplistic behavioural emphasis of the pre-specified coders" (Delamont and Hamilton 1986: 37). Delamont and Hamilton add that classroom research cannot afford to "divorce what people do from their intentions" (Ibid.).

Many writers believe that in case study research, both types of observation are important. McIntyre and Macleod maintain that systematic observation is essential because if only the global issues are studied, the information "collapses" into that global picture and the elements that make it up, are lost. They advocate a flexible approach

which uses systematic observation and considers the contextual (global) factors that cause certain behaviour.

Van Lier (1990: 42) agrees with this when he distinguishes between the "etic" and the "emic". The etic are the instruments and the emic is the context of any research. He argues that a combination of these two is essential, and he refers to this as the "holistic principle". The etic depends on the emic as it is only through studying the context in which a given behaviour occurs, that a full understanding of this behaviour can be reached. In keeping with van Lier's holistic principle, I also describe as fully as possible the context and, where relevant, the macro culture affecting this context.

In my research I set out to develop criteria that would be employed in my observation and analysis. These criteria were developed in consultation with books (Ellis 1990; Vygotsky 1978; Huizenga 1990) and with other lecturers in the English Department who teach multilingual classes. In addition these criteria came from my own experience gained during a pilot study in 1994. From these three sources, I pinpointed the aspects which form the framework for observing input and interaction in a multilingual chemistry class at the P.E. Technikon (see 2.3 and 2.4).

Bassey (in Bell 1991) also emphasises the importance of people in similar situations being able to benefit from the research and claims that this is achieved through vividness of description:

> The merit of a case study is the extent to which the details are sufficient and appropriate for a teacher working in a similar situation to relate his decision-making to that described in the case study. (Bassey in Bell 1991: 7)

Bell (1991: 6) further justifies the single case study when she claims that the strength of this type of research lies in identifying "the various interactive processes at work". These processes may not be obvious in large scale research projects, but they are often the cause underlying the success or failure of the "instance".

Lack of generalisability, reliability and validity are the three biggest sources of criticism levelled at single case study research. All are potential threats to the effectiveness of this research (Yin 1984) and I will discuss what these notions mean and how they can be accounted for in the single case study.

3.3.1 Reliability : the concern for consistency

Reliability is a measure of the extent to which the operations of a study - such as the data collection procedures - can be repeated with the same result (Yin 1984: 45). The aim of reliability is to eradicate researcher bias in a study. However, case studies not only rely on multiple representations of an instance, they are also open to multiple interpretations (Walker 1986). In interpretative research it is highly probable that a different researcher would have a different interpretation of the same event. No claim is made for the researcher's interpretation over anyone else's. Walker believes that the way to overcome the problem of reliability without damaging the essential nature of interpretative research is by making the research as open and explicit as possible. "We suggest that in our emphasis on procedures rather than personal intuition we are moving to a kind of case study research that has high reliability in this sense" (Walker 1986: 202). Yin emphasises this and adds "a good guideline for doing case studies is therefore to conduct the research so that an auditor could repeat the procedures and arrive at the same results" (Yin 1984: 45).

3.3.2 Validity : the concern for the truth

Seliger and Shohamy (1989) define validity as the extent to which the collection procedure measures what it intends to measure. In interpretive research this would amount to ensuring that the criteria on which observations are based are validated by authorities or an external observer so that the validity of the case study is increased. This Yin refers to as construct validity. Yin (1989: 42) gives three tactics to ensure construct validity. The first is to use "multiple sources of evidence" at the data collection stage, in the belief that various perspectives on the situation will reflect reality more honestly than only one perspective. This is endorsed by Walker (1986: 197) who warns that "case studies may create images of reality that become part of the reality itself".

This I have attempted to achieve by holding interviews with the subject, by watching a video of a lecture with her, by giving questionnaires to the students and finally by holding focus-group discussions with the students.

The second tactic is to form a "chain of evidence" which involves observing the same situation repeatedly in order to establish whether a phenomenon happens more than once. Yin states that if something happens only once over a series of observations, it would be inadmissible as evidence of anything other than chance; to guard against this, I attended 5 lectures over a period of 3 weeks.

The third tactic is to have a draft of the research paper read by the person or persons involved so that the description can be validated by them.

Walker emphasises that one of the characteristics of democratic research is the collection of different definitions and reactions to the event described. Thus it is important to gauge the reactions of the observed subject to the findings of the research. In this way researchers are denied the power to impose their own interpretations on the data. Like Yin, Walker believes that this is important for validity because the case study relies on "human instruments" which are open to researcher bias. Furlong and Edwards (1986: 60) stress that what damages research is not just the lack of an open mind but a "false presentation of classroom observations as objective data". The only reliable way to overcome this is to allow the findings to be verified by the person being researched.

3.3.3 Generalisability : the concern for applicability

Yin states that the external validity problem has been a major barrier in doing case studies as critics typically state that single case studies offer a poor basis for generalising. He believes that the lack of generalisability in single case study research is not really an issue providing that the research is open and explicit so that people reading it can relate it to their own needs and situations. However, he gives insight into how a lack of generalisability appears to threaten this type of research. Case study research is always compared unfavourably to the generalisations that are possible from experimental research. Quantitative research tends to rely on "statistical" generalisations whereas qualitative research tends to rely on "analytical" generalisations (Yin 1989: 43). In an "analytical" generalisation, the investigator is striving to generalise a particular set of results to some broader theory. This means that multiple case studies do not necessarily result in more generalisable and therefore more valid data.

What is vital is that the single case study is adequately linked to a firm theoretical base. This is because the theory that led to a case study in the first place is the same theory that will help to identify the other cases to which the results are generalisable (Yin 1989: 44).

Allwright and Bailey (1994) state that in naturalistic enquiry generalisability is not always such a primary focus. This is because naturalistic enquiry is non-interventionist and uses naturally occurring groups, rather than artificially designed or randomly selected groups representing some wider population.

In language classroom research van Lier has argued that generalisability cannot be a major goal because "the first concern must be to analyse the data as they are rather than to compare them to other data to see how similar they are" (1988: 2). Thus the goal in naturalistic enquiry is to understand what happens in the individual classroom, which is itself a potentially unique social context. It may be more or less similar to other classrooms, but understanding the interaction must precede generalising its patterns to other settings.

The whole issue of generalisability looks very different to anyone doing research in the naturalistic tradition. Instead of claiming that whatever has been discovered must be true of people in general, a naturalistic enquirer will claim that whatever understanding has been gained by an in-depth study of a real-life classroom may illuminate issues for other people. In fact we offer "unique perceptions of our world, perceptions that are neither true or false but that simply seem insightful to their readers" (Allwright and Bailey 1994: 31).

Gaies (1991: 207), in an article on classroom process research of which this case study is a part, believes that the immediate goal of classroom process research is to generate hypotheses rather than to test

hypotheses. This premise, he states, explains in large part the avowedly non-prescriptive nature of classroom process research. He concludes that classroom process research does not lead directly to empirically validated applications; rather it is directed at clarifying those factors which must ultimately be taken into account in any attempt to examine the effects of particular classroom treatments.

Walker (1986: 190) states that case studies have as their guiding principle a wish to study the "idiosyncratic and the particular as legitimate in themselves". He therefore disputes claims that single case studies are invalid because their findings are not generalisable. One instance can always be a source of reality to people who read the research. It is the reader who has to ask, "What is there in this study that I can apply to my own situation?" (Walker 1986: 191).

3.4 Ethics

In single case study research of an interpretive nature, ethical questions become prominent. The reason for this is that case study research is "rooted in the practicalities and politics of real life situations ... and is more likely to expose those studied to critical appraisal, censure or condemnation" (Jenkins 1986: 221). It is a social process "leading to a social product" because case studies are public documents "with consequences for the lives of those portrayed as well as for the reader" (Walker 1986: 194). The question this poses is whether researchers have the right to publish their findings at the expense of an individual's self esteem in the knowledge that there is a wider audience who need to know what happens in classrooms. Walker poses several questions which a researcher in the democratic mode has to think carefully about:

* to whose needs and interest does the research respond?
* who owns the data (the researcher or the subject)?

* who has access to the data?
* what obligations does the researcher owe to: his subject ... his fellow professionals, his sponsors, others?
* who is the research for? (Walker 1986: 197)

These would all need to be discussed openly and negotiated with the subject. To this end, democratic evaluation involves an assessment of how justified the claim for privacy is for any piece of research. If the participant has been promised confidentiality and this covers up important information which would be of benefit to educationists then confidentiality frequently takes second place (Elliot 1986). The most that one can promise is anonymity of person and context so that the participants are not identifiable. This needs to be established with the participant at the beginning of the research process so that she is aware of the aim, the audience and the methods of the research. The participant would also need to be left in no doubt about her right to privacy and in which particular areas she could exercise this right (Walker 1986). In democratic research this negotiation should become an integral part of the whole research process.

3.4.1 Ethics, Advocacy and Empowerment

In an article entitled "Ethics, Advocacy and Empowerment... " (Cameron, Frazer, Harvey, Rampton and Richardson 1993) the authors pose the problem of power in the research process, which they believe lies more often with the researcher than with the informants. They ask if this is inevitable and then proceed to show how it need not be, by identifying three frameworks for understanding the relationship between the researched and the researcher. These are, ethics, advocacy and empowerment. They discuss the three frameworks and show that in rejecting the ethics and advocacy frameworks for an empowering framework, the researcher can overcome the "asymmetrical" relationship that usually exists between researcher and researched.

My research goal falls into the empowering framework in that I have been open about the focus of my research with Ms Potgieter and the students. I have attempted to do research with the social subjects and have assiduously interacted and negotiated at every stage of the research process in order to give informants the chance to "maximise opportunities for defining themselves in advance of being represented" (Cameron et al. 1993: 90). Empowering research also seeks to ensure that informants are given the skills so "that those involved in a project are able to have the tools to continue to make critical evaluations themselves" (Ibid.).

An interesting point raised by Cameron et al. (1993: 93) on the prevailing "ethical framework" states that reducing the distance between researcher and researched will destroy the enterprise of research : it will bias the results, muddle the scholarly objectives of academic disciplines and lead researchers into conflicting and irrelevant activities. It will be interesting to see what effect the power relations will have on the findings of this case study.

3.5 Research Process

3.5.1 Choice of subject

It is necessary to explain why I chose the subject I did. As mentioned in the introduction (see 1.2), Ms Potgieter was recommended to me as a lecturer who is particularly aware of the challenges of lecturing to a multilingual class (a relatively new phenomenon at the P.E. Technikon) and whose students were successful in achieving good results in chemistry. Another reason for her suitability in this regard was that she had spent a year of high school in America and had done post graduate study in Chemistry in Israel through the medium of English, which is her second language. These experiences might have enhanced her understanding of and empathy with the difficulties of learning through a second language.

My major reasons for deciding to approach her to participate in this case study can be summarised as follows:

- her reputation as a successful lecturer of multilingual classes
- her interest and willingness to participate
- the specific linguistic make-up of her classes (see 3.1.2) where a sizeable majority are L2 learners
- her willingness to collaborate in any workshops that might grow out of this research.

As part of the coursework component for the M.Ed course I conducted a study investigating input and interactional modifications in a Communication in English class at the P.E. Technikon. This study revealed that very few modifications were being made to accommodate the L2 learners (Potgieter 1994). It is Ellis's (1993) view that in South Africa the tendency is to focus on teaching and learning problems rather than on strengths. These two contributing factors also influenced my choice of lecturer as I hoped that one could learn as much from observing successful language teaching and learning as from focusing on problematic areas in teaching and learning.

3.5.2 Setting up the Research

At the beginning of 1995 I approached Ms Potgieter again to confirm her willingness to be a subject. I explained that I wished to observe about five 45 minute lectures. She again stated that I was welcome to attend any number of her lessons until I was satisfied that I had sufficient data.

We agreed that I would attend the Analytical Chemistry I class. There were 81 students in this group of whom:

55,55% were Xhosa mother tongue speakers

19,88% were English mother tongue speakers

19,75% were Afrikaans mother tongue speakers
2,47% were South Sotho mother tongue speakers
1,23% were Twana mother tongue speakers
1,23% were North Sotho mother tongue speakers

They have 6 lectures per week and the group consists of students studying for the following diplomas: Rubber Technology, Medical Technology, Metallurgy and Analytical Chemistry. Within the group there is a wide range of competence in Chemistry as the various diplomas have different admission requirements.

The next step was to get permission from the students. I compiled a consent form (Appendix A) which I handed to the students during the trial run (see 3.5.4).

3.5.3 Equipment

The Media Department had agreed to video the lectures for me. I asked the cameraman if he could focus on the lecturer and on the students when they asked questions so that I could be aware of the interaction in the classroom. Thus I was able to be a non-participant observer during the lectures and sat towards the back of the lecture room taking field notes.

3.5.4 Trial Run

A date was set for a trial run of the equipment in the classroom. This was to ensure that the students became familiar with the equipment and with the presence of the cameraman, John, and myself. I began by explaining to the students who we were, what the equipment was for and how it worked. The purpose of our visit was explained in detail. I told the students that I was observing input and interaction in a multilingual classroom and that John would be moving around with the

video camera. I stressed that it was important for them to try to ignore us. I then handed out the consent slips and collected them. The trial run went smoothly. Ms Potgieter and the students did not seem distracted by us and the quality of the video recording was good. At the end of this trial run, a date and time was set for the first observation.

3.6 Data Collection

3.6.1 Interview with Ms Potgieter - November 1994

The first stage of the research involved an informal interview with Ms Potgieter in which we discussed the purpose of the research, logistics, and generally discussed our interests and background. We also discussed the context of the Technikon and the transformation that it had undergone in terms of access for historically disadvantaged and under-prepared students, and the impact that this had had on the teaching of one's subject.

3.6.2 Video-taping of lessons

This took place from 31 January to 20 February 1995.

3.6.3 Second Interview with Ms Potgieter

This took place on 4 February 1995 and the procedure used would probably be described as a 'focused' interview (Yin 1984: 83). The questions were open-ended and allowed the interviewer to probe into the context and reasons for the answers.

3.6.4 Viewing of Video of Lesson

Ms Potgieter and I met on Thursday, 9 March 1995 and viewed a section of a video taken from the first lesson that I had observed. I asked her if there was any particular lesson she would like to view, but the choice was left to me. While we viewed the video we discussed aspects of interest and this discussion was videotaped (Appendix G).

3.6.5 Feedback from students

3.6.5.1 Questionnaire

The questionnaire was drawn up and administered on 12 May 1995 (Appendix H). 74 questionnaires were handed out and 65 returned. On the basis of the responses, 7 first language speakers of English and 7 second language speakers of English were approached to participate in a focus-group discussion.

3.6.5.2 Focus group discussions

I decided to use the focus group discussion method as it goes one step further than the questionnaire or interview in that it does not only disclose what is important to individual respondents, "but it attempts to provide a situation where the synergy of the group adds to the depth and insight" (Anderson 1990: 241).

I selected a diverse group of students, both male and female, black and white and from privileged and disadvantaged backgrounds. Their commonality is that they required Chemistry I as a credit towards their diploma and their lecturer is Ms Potgieter.

These discussions took place a short while before the final examination. I tried to generate an empathetic environment in which the respondents felt at ease. Also I tried to ensure that the setting for the discussion was informal and relaxed. As a warm-up I explained the purpose of the study and reaffirmed the commitment to confidentiality. In each discussion I showed a video clip which I used as a point of reference to engage the students in the discussion. I also used comments made by students on the questionnaire and asked the students to discuss them. The discussions were videotaped and transcribed (Appendixes I and J).

3.6.5.2.1 Selection of students

After discussion with Ms Potgieter we decided, first, that it would be better if she were not present during the focus-group discussion as the students might feel inhibited, and secondly, that we would divide the

group in two according to whether students were first or second language speakers. For the purposes of this research we would regard the Afrikaans language speakers as first language speakers because in Port Elizabeth these students are bilingual and their grounding in the subject is stronger than other L2 learners. The motivation for the separate groups was based on affective factors as we felt that the students would feel more comfortable and confident participating in a homogeneous group. We were also concerned that the first language learners might dominate or control the discussion.

I acknowledge the conceptual difficulties around the terms "first and second language speakers" in the South African context. Very often there is a slippage between the terms L1 and L2 and competence and perhaps the issue is really one of proficiency in English. However, for the purpose of selecting students for the focus group discussion I felt it necessary to make this distinction.

The first language discussion group was held on 30 May 1995 and the second language group on 29 May 1995. These discussions were video-taped by the Media Department.

3.6.6 Data base

I have tried to establish a formal retrievable data base for this research so as to increase the reliability of the study. I have kept a journal throughout the research process where I have recorded, in note form, all the interviews with Ms Potgieter and the students. Documents used in this case such as the questionnaire, students' consent forms, and Ms Potgieter's comments on the draft of the report, have also been filed and stored so that they are readily available. The video-tapes and the audio-tapes and the transcriptions have been filed and form part of the data base.

3.7 Problems encountered in carrying out the study

3.7.1 Interviewing

There are a number of problems with interviewing as a research methodology and it is important for the researcher to be aware of these so that she can attempt to avoid bias as much as possible. In the interviewing situation the interviewer is in a powerful position to influence the data that is gathered by imposing her own definition of the situation on the participants. As Kidder and Judd (1986) point out, it is not only the interviewer's attitudes that may influence responses, but the interviewer may have certain expectations of the interviewee which may distort the data. I hoped that by presenting the findings of the research to Ms Potgieter for discussion and criticism, she would be able to identify bias on my part and correct it.

3.7.2 Focus-group discussion

White students were more forthright and more critical than the black students. It is well-known that the respondents' perceptions of the interviewers' characteristics such as race and social status bias the responses (Kidder and Judd, 1986). I was concerned that black students saw me as a white staff member of a technikon which is still perceived to be a predominantly white institution. Because we are dealing with human factors, the kinds of biases described above can never be completely overcome. Also, my inexperience as facilitator in a focus-group discussion led to many unexplored avenues and dead-ends.

Another cause for concern at the time was the feeling that there was too much consensus in the responses by both groups. However, this aspect will be dealt with in the Findings chapter (see Chapter 4).

3.7.3 Theft of audio-tapes

A major setback in the research process was the theft of the audio-tapes of my first interview with Ms Potgieter and the audio-tape of Ms Potgieter and I viewing the video of her lesson. I had not made copies of the tapes nor had I transcribed the information as the tapes were locked up in my office and presumed to be safe.

I had to approach Ms Potgieter to ask if she were prepared to re-do both the interviews and the viewing of the videotape of a lesson which would involve at least 2 - 3 hours of her time. Ms Potgieter was most supportive and readily agreed to re-do the interviews.

On reflection when I transcribed the data I do not think that re-doing the interview altered Ms Potgieter's input, but I, as an interviewer, was more relaxed and therefore not so tentative. There is a downside to this, however, as many of the questions asked in the interview were closed, and I believe this was in order not to waste too much of the interviewee's time. When we re-viewed the video of the lesson Ms Potgieter commented that she could be more reflective in the second viewing as she had been too distracted by seeing herself "perform" or "clown around" as she put it, in the first viewing. Thus my anxiety about imposing on Ms Potgieter's time to re-do the viewing of the video was allayed.

3.7.4 Researcher's response to case study research

There has been an interesting development in the relationship between Ms Potgieter and the researcher. Ms Potgieter has completed an M.Sc in Chemistry and is at present working on research for her doctorate, while the researcher is a novice in the field of research. Although Ms Potgieter is a novice in the field of language research, there has been

a subtle development in my dependence on Ms Potgieter for advice and guidance in the processes and principles underlying research procedure. So, although my research is placed in the empowering framework (see 3.4.1) from the point of view of the informants, the researcher has found the process "empowering" to the extent that Ms Potgieter has assumed the role of mentor and confidante.

Thus being involved in case study research presupposes initiating and sustaining a relationship so that the research is possible. Also a case study worker is heavily dependent on personal trust and I realised as the research progressed that I felt uneasy about the intimacy of this relationship. This is no reflection on the attitude of Ms Potgieter, but rather on the researcher who baulked at being beholden to someone else and would rather have worked independently.

The theft of the audio-tapes compounded this feeling as I became very anxious and embarrassed when I had to approach Ms Potgieter and ask her to re-do the interviews. As previously mentioned, she was as enthusiastic and willing as she had been about the first round, but the feeling of being involved in a "critical and often precarious relationship" (Falmer 1990) returned very strongly.

3.8 Summary

In this chapter the case study as a research strategy has been described and I have attempted to show how it seemed to meet the needs of my research project. Case study research is complex and seldom free of problems and I have outlined some problem areas that emerged during the research process.

CHAPTER FOUR

ANALYSIS AND FINDINGS

4.1 Structure of chapter

One of the goals of this research project is to gain a clearer understanding of how adjustments in input and interaction in a multilingual chemistry classroom have a bearing on the quality of learning in that subject. (1.1 Aims of research)

This analysis will cover the observed lessons, the interview with Ms Potgieter, the viewing of the video with Ms Potgieter, the questionnaire responded to by the students and the two focus group discussions held with L1 and L2 learners.

In order to ensure that I was not making wholly subjective evaluations, I have attempted to support my judgements by drawing on the work of theorists, especially on the characteristics of input as described by Huizenga (Chapter Two) and the Vygotskian view on cognitive development (Chapter Two). Also I have used feedback from the students' comments on the questionnaires and from the focus group discussions to underpin my analysis.

4.2 The role of language in the construction of knowledge

Vygotsky (see 2.1) emphasised the essential role that language plays as the predominant semiotic tool in the construction and production of knowledge.

The data reveals that language is used to construct knowledge in a number of ways. In the following extract the lecturer is teaching the concepts of "precision" and "accuracy":

Extract from lesson on Significant Figures on 20 February 1995

L: *But first we must look at the concepts of precision and accuracy (writes terms on the board). To some people like me, I'm not very good at English, they sound the same, right?*

Now accuracy I can explain like this. Say I want to weigh off a certain amount of sodium chloride, salt. I want to weigh off 1,000 grams of salt (writes this on board). So I get a scale that can go up to 3 decimals or a balance, there are some of them in the lab. Then I go and weigh a lot of samples, but it's difficult because maybe I have big pieces of salt there. Let's say, I am weighing some samples and I have a student weighing some - Person A and B (writes on board).

A	B
1,002	1,005
1,001	1,006
1,000	1,005
0,999	1,005
0,998	1,006

Let's look at these results. What do we see? Which guy's results are closest to what we want? A or B?

Sts: *(Chorus) A.*

L: *A is much closer to what we wanted. We say that A measured quite accurately in the sense that he was the closest to the value that we want, but B was far away. Is that right? So A is closest to the value of 1,000 grams. So we say there was sort of a good accuracy - accuracy has to do*

with how close I am to the truth. A is closer to the truth than what B is. (writes on board accuracy = truth)

Firstly, in the above extract the lecturer draws on the common sense notions of "accuracy" and "precision" by saying "they sound the same to me". She then builds up to the precise, specific meaning in scientific discourse of "accuracy" meaning "truth" with a practical example illustrated on the board. She seems to realise that ordinary language and common sense experience is what students bring to class (she refers to two people actually weighing the salt) and thus uses these (i.e. ordinary language and common sense experience) to mediate the concepts. In Vygotskian terms, this is a form of scaffolding (Bruner 1985), as the level of the scientific concepts to be learned is matched to the level of the audience, without causing conceptual confusion.

Secondly, also within a Vygotskian framework, the lecturer seems to acknowledge that she is faced with students whose zones of current thinking vary widely, and thus she proceeds from the known to the unknown, from the concrete to the abstract, and then sometimes from the abstract to the concrete, bringing together everyday and "schooled" concepts to form "true concepts". In the above extract she started with an explanation of: *"this is closest to what we want"*
which changes to:
"A is closer to the value that we want"
then the term "accuracy" is introduced:
"there was sort of a good accuracy"
and the lecturer moves to the definition:
"accuracy has to do with how close I am to the truth"
and finally to the two key terms:
"accuracy = truth"

In the explanation of the concept "precision" we see the same progression.

L: *Let's look at A. What is the highest value A got?*

Sts: *1,002*

L: *And the lowest?* *(Writes on board)* 1,002

0,998

difference 0,004

Sts: 0,998

L: *This is the difference (0,004) between the highest and lowest value. Is that right? So this guy didn't have a high precision in measuring, in other words, he had a big range.*

Let's look at B. What is the difference between the highest and lowest values? 0,001 (writes on board). So this guy is more consistent, he gets the same thing every time, so he is precise, but he is not accurate because he is not close to what I wanted. This doesn't really happen in life because if somebody is precise he is also usually accurate, but I gave two examples so you could see the difference between accuracy and precision. So accuracy has to do with the truth or the range?

Sts: *The truth.*

L: *The truth. And precision has to do with the ....?*

Sts: *Range*

L: *Range. Right. Write the words down (does this on board)*

accuracy = truth

precision = range

Again the lecturer began with a concrete example of the difference between the values of A and B. And then through a comparison she leads the students into understanding the concepts of "accuracy" and "precision" and the difference between them. Thus the learning of the scientific concepts was mediated through the everyday concepts.

Ms Potgieter clearly understands the need to predict difficulties with meanings of words beforehand and make this difference in meaning clear so that students are able to internalise the disciplinary dialect (Ballard and Clanchy 1993). In the introductory interview held with Ms Potgieter, she made the following comments which give insight into the way she believes language constructs knowledge:

38. *L ... A guy that gives electrons we say gets oxidised, but then that thing is a reducing agent. Now it's all just words that actually mean something. Then I try to explain it, maybe through association with it and use other things to explain so that they can actually see what I'm talking about. You don't actually know the meaning but you can figure all the words out. You don't have to go and learn if something gives, it is oxidised and is a reducing agent, you don't have to learn that, because if you understand what the word means you think it up and actually create the concept and that's really what I want to get at, because when they know they do not have to bother about learning like a parrot, they can actually create it.*

The lecturer seems to emphasize understanding the concept rather than rote learning ("learning like a parrot") because she believes that understanding will give the learner the confidence to "create the concept".

In the previous extracts there was evidence of "concepts being created" and in the extract below the data also reveals this process taking place.

Extract from the first lecture on The Periodic Table 31 January 1995

L: Have you heard of polyester?

Sts: No (chorus)

L: It's some material you can buy. In the old days we used to have cotton which comes from a plant, so if you can't grow plants you think of something else. Polyester is the material that you buy - they

mix it with cotton - now poly means a lot of what? Esters. Esters is not a lot of girls but is a type of chemical bond that you can form and in polyester this is a lot of? Esters. You will learn about esters next semester. So polyatomic means I have more or a lot of atoms.....

In the above extract the concept "ester" which is a type of chemical bond and the term "poly" are being taught. The lecturer begins with the known-material (polyester) and then examines the root of the word "ester" - "esters is not a lot of girls but is a type of chemical bond". She then moves onto the prefix "poly" which means "a lot of" and attaches this to another root "atomic" and the concept of "polyatomic" - many or a lot of atoms, is taught. Through this progression, she believes that the learners will be able to understand what the word means and be able to create their own words/concepts.

The data also reveals that analogies are used to help form concepts:

<u>Lecture one 31 January 1995</u>

L... Right, mercury likes to be +1 and +2. When it is +1, it cannot be by itself. It is like some people. Some people like to be with somebody, others like to be by themselves. Do you know people like that? Now, Mercury +1 hates to be alone - we never find it by itself. So if I write Hg +1 it is wrong because I will never find one of those by themselves, they will always come with another one.

In this extract the behaviour of Mercury is associated with the characteristics of people - "some people like to be with somebody, others like to be by themselves ... Now, Mercury +1 hates to be alone - we never find it by itself". In this way it seems that the lecturer wants the students to have alternative ways of internalising the concept, so she uses different strategies to facilitate this.

In the introductory interview Miss Potgieter states her reasons for using this strategy:

28. L: *Chemistry traditionally has been taught often as something you learn off by heart, just millions of formulaes. The lecturer would stand in front of the class and write things on the board or give you thick notes and then you have to learn - there is no reason, sometimes there is, but for lots of people it's always been like that. If you really think of Chemistry, it is the behaviour of small particles - molecules and atoms, so if you can imagine what these things look like and start to learn their characteristics, like people, it is much easier to understand. If you can form some association, not just an abstract formula on the board - you must picture them in your head.*

She adds:

30 L ... *I don't really sit down and prepare but whenever I wake up at night or am walking, thinking, what can I use to explain, what association, what picture to explain this thing that will crop up in a lecture ...*

In the following extract from a lecture on 7 February 1995 this strategy of making analogies so that the concept is concretised is evident:

<u>Lecture two 7 February 1995</u>

L: *Now the proton in the middle is the size of a pea in the middle of a field - you know peas - those round, green goodies that you have to eat because they are good for you, some of you don't like them - that pea in the middle of the soccer field is the size of a proton if the atom is the size of a soccer field.*

In this example the size of an atom is compared with a soccer field and the proton with a pea. In this everyday way these can be visualised by the students in a concrete, real way rather than being vague, abstract terms.

The students' response to "associations" or creating images in the focus group discussions was very positive:

L1: Another thing is like when she tells us stories about these chemistry people and her experiences, it becomes interesting and when you are writing a test or an exam you think of the things she told us in class and it actually is easy to remember.

I: So even when you are writing tests you make those associations?

Sts: (chorus): Yes

4.2.1 Language Modifications

In all of the quoted extracts from the lectures there is evidence of language modifications to ensure that understanding is facilitated:

Lesson one The Periodic Table 31 January 1995

The paraphrasing of peas:
"you know those round green goodies that you have to eat because they are good for you"

The lecturer does not assume that the students share a common frame of reference and will therefore be familiar with the vegetable "a green pea". Also the paraphrasing gives students' time to process what the lecturer is saying which is especially important for L2 learners.

Significant Figures 20 February 1995

"this guy is more consistent, he gets the same thing every time".

In this extract a synonymous phrase "he gets the same thing every time" is given for the term "consistent". It is important that this word is

understood as it is fundamental to the understanding of the concept of "precision".

Extract from Balancing Equations 13 February 1995

L: *These two mixtures form a self-igniting mixture. What does igniting mean?*

St: *Set alight.*

L: *That's right - burst into flames. If you mix these guys they'll just explode. What will they form? Nitrogen and water.*

In this extract the students are asked to give an explanation of the term "igniting". The students' response of "set alight" is confirmed and then a synonymous, more everyday phrase is given: "burst into flames". Further on another dimension is added to the meaning by "they'll just explode". By this stage, the term "self-igniting" should be understood by every student whether an L1 or L2 learner.

All these modifications seem to strike a balance between scientific understanding and learner accessibility, particularly L2 learner accessibility. Perhaps Ms Potgieter uses these language modifications because firstly, she is a second language speaker of English herself and completed her high school, undergraduate studies and honours through the medium of Afrikaans.

Secondly, she completed her MSc in Chemistry at the Weitzman Institute in Israel, and it was here for a period of two and a half years that she experienced being in a "foreigner-talk" environment.

In the introductory interview she observed:

44. *L: You don't have family there so you become family and there is not very good communication, so you learn to communicate a lot of things with very simple language because you haven't got the vocabulary to communicate that. I think that taught me, because gestures and your body and your eyes, you can say so much. You can use a very simple word but you can add a lot more to it. I don't think about it, really, it just happens.*

Thirdly, Ms Potgieter's high school teaching experience of three years was in a bilingual/dual medium classroom. She found it easy to switch from English to Afrikaans and believes this experience was very valuable in making her more aware of the linguistic needs of the pupils.

20. *L. Sometimes they had both languages in one class when they did not have teachers, but kids don't have problems with languages in a dual medium school.*

The response from the students in this regard was very affirming:
St: Miss Potgieter understands the problems of L2 learners (statement by student in L2 focus group discussion).

Also, the students' responses to the question on language modifications in the questionnaire were revealing. Of the 65 returned questionnaires, 14 students replied that language modifications in the lectures made no difference, however, 11 of these were L1 speakers. On the other hand, 32 of the students responded that they found them very helpful and comments included:

L2: Some of us English is not our first language, so it is very good to do that.

L2: She tries the best she can to make you understand.

4.3 Contextualisation and comprehensibility

It is difficult to separate the previous discussion from the notions of contextualisation and comprehensibility as described by Huizenga and Wong Filmore (Chapter Two) as they are inextricably interwoven: if you do one, you do the other.

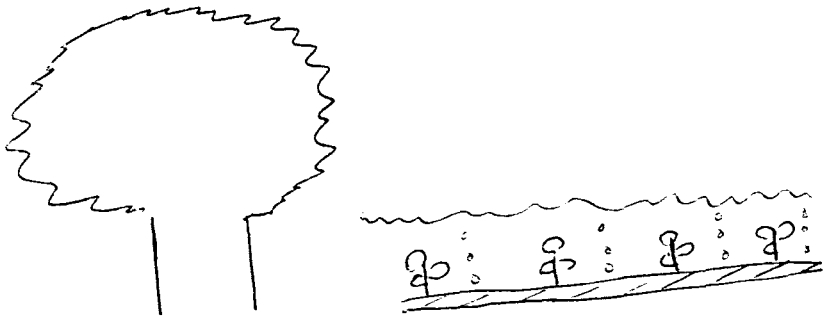
The data revealed that contextualising the subject content was an important strategy for increasing comprehensibility.

Extract from Lesson on Balancing Equation 7 February 1995

L: Let's quickly look at another reaction in our textbook. Let's take methane gas.

$CH_4 + O_2 \rightarrow CO_2 + H_2O$ (writes this on board)

Another word for it is marsh gas. Who knows what a marsh is? In more modern days we can call it something else - we can call it rubbish dump gas. Now when we have a marsh, it's basically a piece of land covered with water, but not a very thick layer of water - there are plants growing there. What happens at the bottom of this - it's not really a dam it is really a vlei covered with water. (draws on board):



At the bottom there is mud and stuff - there is bacteria growing underneath there. What happens in this marsh - let's have a couple of plants and

weeds - but down here is no oxygen - when there is no oxygen present we say it is an anaerobic situation - aerobic means oxygen, you know those exercises you do when you have to breathe a lot of oxygen.

Anaerobic means little oxygen or no oxygen at all. Now these bacteria love it when there is no oxygen, but instead of exhaling CO_2 they breathe out methane which is quite explosive - it's related to those things you put in your cigarette lighters. So what happens is the little gas bubbles come to the top and it's quite hot in these areas and the methane gas explodes by itself - so if you are on the marsh at night it is actually quite exciting because you sit and you see flames coming out all over the show - it's the methane gas that's coming out. That's about the only thing methane is good for and that is to burn. Methane reacts with the oxygen as it comes out of the water - comes to the top and it is very hot there and it reacts with the oxygen which is in the air (writes on board).

$CH_4 + O_2 \rightarrow CO_2 + H_2O$ *reacts to form carbon dioxide and water.*

Here "living knowledge" has been used as a context for conceptual development. Firstly a marsh is compared with a rubbish dump as the same chemical processes are at work there. A marsh is explained in a diagram and is also compared with a vlei which is a South African word and therefore probably more familiar to the students than "marsh". This concept is made more real and accessible through the diagram on the board illustrating a marsh and the reaction that takes place.

Next the word aerobic is explained by reference to "you know those exercises you do when you have to breathe a lot of oxygen?" The meaning is developed by adding the prefix "an" forming the opposite "no oxygen".

Thus an understanding of the reaction of methane gas (CH_4) and oxygen (O_2) is facilitated in a very real way.

The knowledge in the above extract is contextualised and perhaps in this way comprehensibility is increased.

A student's response corroborated that this strategy increased comprehensibility:

L1 ... it's not like at school when you learn a subject you know you are learning the stuff but you are never going to use it, you are learning it to get a mark, but this stuff you know you are going to use sometime, somewhere, it makes it real.

Thus in terms of Cummins and Swain's (1986) continua (Chapter Two), the communication is context-embedded because language is supported by contextual cues and participants can actively negotiate meaning by integrating the known with the unknown.

4.4 Affective factors

Another aspect highlighted by Huizenga is the importance of a positive affective environment, which she believes can influence how much input is converted to intake.

Rounds (1987) in Flowerdew (1994) has provided a description of a number of interpersonal features of mathematics lecturers. Of particular interest in Rounds' analysis is the emphasis put on the ability of competent lecturers to develop "an atmosphere of co-operative interaction and consensus - a sense of working together to achieve a common goal" (p. 666). Rounds calls this "elaboration", as opposed to the mere transmission of information.

In creating "an atmosphere of co-operative interaction" lecturers need to be aware of feelings of dislocation in NNS students. Ballard (1984: 48) refers to the "double cultural shift" that the incoming NNS students faces,

especially in traditionally white institutions: the transition from high school to the tertiary environment and also the move into an alien culture, with different norms of authority, relevance and criticism. He states that in particular the basic issue of the relative statuses and rights of learners and teachers will affect whether and to what extent NNS students actually take up the available support in the host academic system.

Ms Potgieter seems very aware of the need to create "an atmosphere of co-operative interaction". When watching the video she voiced her own uncertainties on that first day:

9. *L: It felt so strange that first day, they're all so new, you don't know how things are going to turn out.*

And despite the fact that this is the biggest class of first years she has taught, she is determined to "get through to them". (personal communication by Ms Potgieter to researcher).

11. *L. I've never had such a big class here.*

13. *L. It makes it more difficult, they don't really talk, you don't really know if you are going to get something out of them. You use a lot more energy to get something out of them. I'm trying to get them to relax a little bit ... I start with this because they need them in other subjects.*

21. *L: Do you see that they are talking? I didn't expect that the first lesson, not knowing any of them. You can see they are checking me out.*

Data revealed that a rapport was built up between the lecturer and the students, starting with the first lecture and developing every week:

Extract from Lesson One: The introduction to Lesson One: The Periodic Table 31 January 1995

L: (writes on board): *Bounis dias*

שלום

good morning

molweni

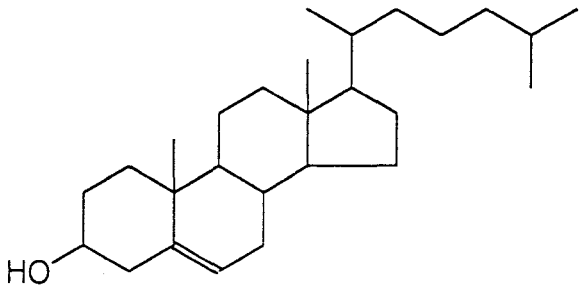
bon jour

goeie môre

dumelang

(much laughter from students)

Okay, today we are going to talk a little about language - you are going to start learning the language of Chemistry. Now in Chemistry of course you don't use normal alphabets like people in the world do - we use other things to show our formulae. Is this the language we use in Chemistry? (Draws on board).



What is this? Have you heard of cholesterol before? Ja sure that's cholesterol. But if I don't translate it for you, you won't know what it is. When I put these words on the board everyone was really surprised - you didn't know what was going on, so I put Xhosa for you because some of you understood what that word means, and then I put English so that everyone knew what we were talking about or were there still people who didn't understand? Now what we are going to do in our Chemistry course today is we are going to start to learn how to name compounds ...

As an introduction to a course this seems to be a very sensitive, user-

friendly approach to a multilingual class and an innovative way to introduce the topic, the language of chemistry.

When viewing the video, I asked Ms Potgieter why she began like that and whether the fact that I was in the class that day influenced the introduction. She replied:

6. *L: I don't know. I take it as the mood ... it influenced it probably.*

7. *I: Because that was the objective of the lesson - the language of Chemistry.*

8. *L: But I've never done that before - I just thought it up. You could have influenced it - probably you did. I tried to get something that would fit in.*

Thus from the beginning Ms Potgieter attempted to create a positive climate in which all students would feel accommodated.

Also worth noting is the fact that Ms Potgieter is influenced by my presence in the classroom. Although I tried to be an unobtrusive non-participant observer and Ms Potgieter is a confident, experienced lecturer who is herself involved in research for her Ph.D in chemistry, she is nevertheless affected by the fact that I am there and that the lecture is being video-taped. This seems to endorse the view that classroom observation is not always the most appropriate way to gather data, because of the likelihood that being observed will change people's behaviour (Allwright and Bailey 1991).

However, one must bear in mind that this was the first lecture of the semester. I observed five lectures thereafter over a period of a month and it seemed to me that my and the cameraman's presence had very little effect on the way in which Ms Potgieter presented her subject.

The data also reveals that Ms Potgieter is in touch with the students and understands their point of view:

L1 student in focus group discussion:

"She isn't like a lecturer, she is more on a personal level, she isn't like, she's there and I'm here."

L: *Read chapter ... on Lewis structures before tomorrow. It is a good bedtime story, you're guaranteed to sleep like a baby after you've read it.*

Sts: *(laughter)*

L: *In Chapter 8, skip 8.2, it gets complicated, then you won't fall asleep, you'll start panicking.*

Sts: *(much laughter)*

Here the use of humour in the class relieves tension and lightens the atmosphere.

There is much evidence in the data of Ms Potgieter creating "a sense of working together to achieve a common goal" (Rounds 1987).

L: *You are thinking how on earth am I going to remember all this? Well, the answer is to do lots of balancing equations, there are lots in the textbook. I think we must take a break.*

Sts: *Yes.*

L: *Think about it. Let it sink in, don't let it fly out of your head now. When you come back we'll add a little bit to it and then we have finished balancing equations. If you have any questions, come and see me.*

She encourages the students by echoing their thoughts "You are thinking how on earth am I going to remember all this?" and makes them believe that she understands their problems and they are in this together "and then we have finished balancing equations": the use of "we" rather than "you" suggests co-operative action.

In the observed lectures the lecturer always appeared uninhibited and confident, and this seemed to relax the students:

L: Some of you are looking at me as if I am crazy, maybe I am a little crazy.

That she has been successful in creating a positive climate in the classroom is endorsed by comments from both the questionnaire and the focus group discussions.

L1 I enjoy this lecture the most. I was never really interested in chemistry until I started this course.

L1 The class is relaxed and not formal.

L2 Everyone is free in the chemistry class because the lecturer is also free with us.

L2 I feel comfortable in class because the lecturer knows each and every one in the class. I sit on the front seat which makes me feel comfortable.

L2 She assures we understand - not just rushing into finishing up. I think she is quite good at lecturing chemistry.

L2 At school I wasn't good at chemistry but now I can do it.

L1 focus group discussion:

St3 *You find with Miss Potgieter that she has made a point to learn names, all the Xhosa students' names, and if she like asks a question, she doesn't pick on the same people, she tries to spread it around, I mean with us being English we have easier names ...*

This comment is particularly noteworthy as an L1 student has observed that Miss Potgieter wants all students to feel involved. Very often, from my own personal experience, one shies away from using the difficult, unfamiliar names of students and in this way so much interaction is lost with the very students who often need to negotiate meaning and establish rapport with the lecturer. Secondly, this comment endorses Wong Fillmore's point (see 2.4.3) that through questions the lecturer can advocate clear and fair turn allocation procedures, thus ensuring that everybody gets a turn and the more reticent student is not ignored.

4.5 Questions

Possibly as a result of the positive affective environment described in the previous section, the data reveals that students, and in particular L2 students, are more than prepared to ask questions and to offer explanations in class.

In the following extract from Lesson one on 31 January 1995, an L2 student offers an explanation to a question which was asked by a student and to which he felt the lecturer had given an inadequate reply.

L: *Did that answer your question?*

St1: *(L2) Yeh - sort of.*

L: *Sort of. You must ask me to still explain if you are not sure. Will you think*

about it and come back to me?

St1: *Yes.*

St2: *(Another L2 student) What about looking at it from this point? Let's check (indistinct). So if it's true it may be (indistinct) which only 1 electron - so if it combines with another it is 2 electrons.*

L: *No, not necessarily.*

St2: *Does it become 2+ if it gives away 2 electrons?*

L: *Yes, it becomes 2+ if it gives away 2 electrons...*

This interaction occurred in the first lecture of the semester. When viewing the video Ms Potgieter commented on this:

L: *I didn't answer his question actually, only much later. One of his buddies helped me. I'm telling them a story but it's not really what he asked.*

The fact that one of the student's peers helped him to understand links with Vygotsky's belief that it is very often through interaction with peers that the learner is stretched to the limits of her ZPD.

The data reveals that many of the questions asked by the lecturer are substitution type or rhetorical and answered by herself.

Lecture Two Balancing Equations 7 February 1995

L: *No. It's only got to do with the ..*

Sts: *Hydrogen.*

L: *Hydrogen. If I have one carbon here, how many do I have there?*

Sts: *One.*

L: *One. How many hydrogens here?*

Sts: *Four.*

L: *Four and over there?*

Lecture Four Significant Figures 20 February 1995

L: *Anybody found anything? No? Where did you look? Did you look in the index for nitrogen?*

Also many of the questions were gap filling:

L: *Copper 2+. So you will write it like this and this one? (points to board)*

St: *(L2 student) Copper one.*

L: *Copper one. These are the easy names. Now what about the more difficult names? Latin?*

St: *(same L2 student) The one on top I say is cupric.*

L: *Cupric. And the gentleman there, what will we call this one?*

St: *(same L2 student) Cuprous.*

L: *Cuprous, that's correct...*

What this extract clearly shows is that this questioning strategy used by the lecturer, where there was very little risk involved for the students, is a way of building solidarity in the classroom. The students are providing responses which are actually repeating information on the blackboard or information that has been recycled again and again.

Ms Potgieter also uses a lot of formulaic language - "Is that right?" "Do you understand?" - and together with the chorusing of students' responses, it appears to create a sense of participation and co-operation and of learning taking place.

The students' responses were extremely favourable in this regard.

Question 11 on the questionnaire asked:

Do you feel comfortable asking questions in class?

Total	Yes	No	Sometimes	No Response
65	40	23	1	1

The reluctance of those who said 'no' might have resulted from their lack of proficiency in English (real or imagined) and shyness, rather than from the unapproachability of the lecturer.

Four students commented:

The problem is that I am not able to speak English properly and I don't like to be laughed at because of that.

Six students responded:

It is usually a mass lecture so I get a bit shy, but I don't mind asking her.

Those who said 'yes' commented:

L1 The lecturer does not mind explaining again and she does not make you feel stupid.

L2 Because the lecturer doesn't become scared when we are asking the questions instead she's very happy.

L1 I know that however stupid/naïve my question is the lecturer will still help me.

4.6 Pragmatic features

The data reveals that Ms Potgieter seems to have realised the value of using other symbolic systems such as diagrammatic representations, role play, paralinguistics and story telling to help reveal and crystallise ideas.

<u>Extract from Lesson one 31 January 1995</u>

L: So two Hg^{+1} will come together and what I must do is write it like this Hg_2. What does the 2 down there mean? It means I have two of these guys (points to Hydrogen on board). Another way of writing it is .... somebody said an atom could be represented by a little ball (draws • on board). Let's say that is a $\dot{H}g^{+1}$. It can never be by itself, it will always take another guy ($\dot{H}g^{+1}$ $\dot{H}g^{+1}$) will come together and they will look like this:

$$\bullet\bullet^{+2}$$

Here the lecturer tries to represent the atom through a drawing/picture. She builds on this later in the lecture in response to a student asking for clarification:

L: It means that I have two guys stuck together and now it is very important that I have a picture in my head - I would see two guys stuck together like this $^{+1}\bullet\bullet^{+1}$. Each one would be +1 - this whole thing together would be +2. How many atoms do I have here?

St: Two.

Extract from Lesson one 31 January 1995

L: This is my electron (holds up a piece of chalk). This electron is moving very fast around me (lecturer moves arms and chalk in circles round body), so it is using a lot of space around me. If I give it away, what happens? I am going to look a little smaller because this electron is not running around me. If I give away two electrons I will look even smaller. Right? Because if I have two electrons both arms have to move. Right? So which one would you think - this guy with the 2+ must be smaller than the one guy with 1+. Isn't that so? Okay. To make the difference I'll make this one a little smaller. Does this thing $^{+1}$ *and this thing* $^{+1}$ $^{+1}$ *look the same? (points to drawing on board). Do the pictures help? The gentleman in the nice, checked shirt who asked me the question, do you have the pictures? That's good. I think the picture is much clearer than this (points to symbols on board). So when we see this (symbol) in our head we must see that (pictures) as well.*

In the above extract we see a combination of body language (lecturer moving arms and chalk in circles round body) and pictures in order to explain the concept.

The following statements were made by the lecturer during lectures, and show how she overtly explains to the students why she uses this particular strategy. Also she points out that pictures help her to understand concepts, implying that the students, too, should use this strategy to facilitate understanding.

Lecture 7 February 1995

L: "You think it is boring to draw the pictures, but that is what it really looks like - you have to have magic glasses, it gives you a better idea".

and

Lecture 13 February 1995

L: I like to draw pictures, all right, maybe I'm a kid still, I don't know. If I draw a picture it's easier for me to see what is going on.

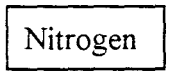
In the following extract the concept of the Lewis structure and the 8-electron rule are being taught through the use of a diagram.

Extract from lecture on Oxidation States 13 February 1995

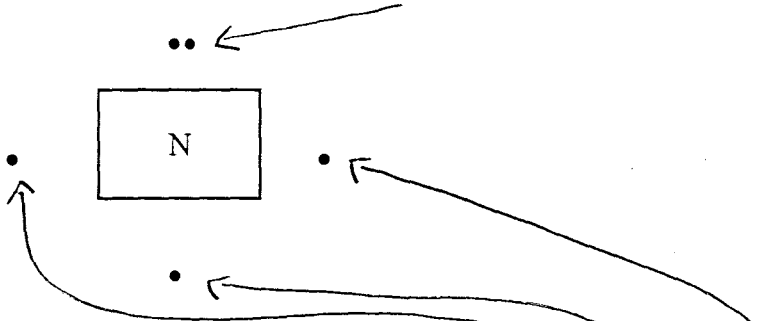
[An energy diagram]

What we imagine is the elements in a little box.

(Draws on board)



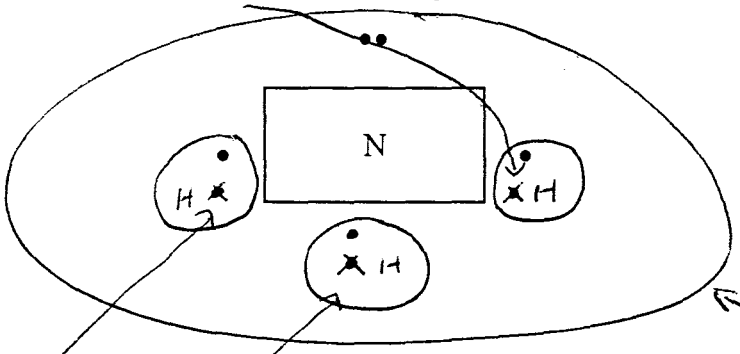
Each side of the box can have two dots on it. These two guys are together so they go together on one side of the box here



If you have three separate ones, each one will go here, here and there. Now this (points to diagram) is called the Lewis Structure. I don't draw the sides of the box, I have put it like this so you can see how they are arranged. You don't just sommer put them around this nitrogen anywhere

you like - if I have two electrons together in an orbital they must be together on one side of this symbol as well. This tells me this Nitrogen has five electrons and these electrons can be given or taken or shared. Normally if you have one electron on the side it can share with somebody else for example Hydrogen. Hydrogen has only one electron. A diagram of hydrogen looks like this. (picture on board) There is only one electron in an orbital. So I'll use another colour and say the Lewis structure for Hydrogen looks like this, it only has one electron:

Let's look at the electron story. We see with the Nitrogen there is space for another electron here, so a Hydrogen can come and share its electron.



Another Hydrogen will say I'll give another electron, let's share and form a bond and another.

Normally when we draw a Lewis structure of the way atoms combine, if we had to look at an element, say Nitrogen and we draw a circle around - they are usually 5 but they like to combine to form 8 electrons. Not all these 8 electrons belong to the Nitrogen - the Hydrogen does give some so that we can share so these are 3 of the electrons that have been donated, so they are sharing it. The Nitrogen is happy because it has 8 electrons around it. There is a rule in Chemistry, we call it the 8 electron rule, the elements like to combine in much a way that they have 8 electrons around them. The only exception is Hydrogen will always like to have two. This is called the Lewis structure for Ammonia. There was a Chemist by the name of Lewis

and he thought up these structures. We use them for a lot of purposes and they make life easy.

The above data illustrates how the concept of the Lewis structure and 8-electron rule are taught. The lecturer systematically builds up the knowledge, starting with the element of Nitrogen. Each step is developed on the blackboard through diagrams, so the knowledge is illustrated and re-inforced aurally and visually. Through the lecturer's use of different colours and by her building on the drawing, I believe these concepts are rendered clearly comprehensible.

Typical of the lecturer's style is the use of colloquial language "You don't just sommer put them around this nitrogen anywhere you like". Although this is an important scientific principle, I believe her informal style makes the information more accessible and less intimidating and therefore actually reinforces the principle.

In the introductory interview Ms Potgieter pointed out why she used these strategies:

28. *L: I had a lecturer in my second year at Varsity that helped me, that helped me, that made it alive like that. He used body language and us and whatever to explain the concepts, so suddenly, although you couldn't see the molecule, you could imagine more or less what it was like ....*

... Now when I think of a molecule, I see it. You have to see in three dimensions which is not always easy. You must be able to turn this thing round in your head and be able to look at it from different sides and that is what my side of Chemistry is all about - to see something in a molecule which nobody has seen before, to really look creatively and um, that was, um, and then I started thinking, how do I actually bring this across to the students, because we often think that this is what students have in their

heads, but when you get feedback you get the opposite or get something completely different or you emphasize things but they actually picked up things that were completely different or were not that important.

This experience along with her experiences in Israel seem to form part of Ms Potgieter's apprenticeship for teaching multilingual classes.

This approach is verified and appreciated by students.

L1 *"It (*use of gestures, graphs, etc.*) makes us look at the work in a totally new perspective. Makes learning fun".*

L1 *"She goes in from all angles, pictures ..."*

L1 *"She does different things all the time, you don't know what to expect".*

L1 *"She really livens it up. She draws pictures, tells stories".*

L1 *"I mean the whole thing is basically that chemistry can be an extremely boring subject because it's just supposed to be straight forward learning. She makes it more understanding than learning".*

L2 *"The pictures are helpful when I don't understand something".*

L2 *"I learn and remember things better if I hear and see it at the same time".*

The last comment by a student seems to dovetail with Ms Potgieter's comments in the interview: "... then I started thinking, how do I actually bring this across to the students, because we often think that this is what students have in their heads, but when you get feedback you get the opposite....". This student believes these strategies not only liven up the subject, but also clarify concepts and facilitate understanding.

It is in the light of Vygotsky's ideas about play, imagination, concept development and literacy that I wish to comment on the use of role-play and paralinguistics used in the observed chemistry classroom. In every lecture

attended role play was used, in fact, role play was used in the first lecture, although many of the students might still have been feeling strange and uncertain.

Extract from Lecture one 31 January 1995

L: ... Who likes to act? I'm looking for a volunteer. Come on. Nobody wants to come. I can't explain on my own. (students not establishing eye contact and giggling). I won't eat you - I've had breakfast - You must come (student in front row). Now look at this (points to pen) she has even brought her electron with her. Now we are both Mercuries - now we must give away our electrons (they both hand pencil and chalk to students in front row) - she is +1 and I am +1 but we don't like being alone, we like to be together (lecturer links arm with student) - when you see us what do you see? +1? You see +2. Do you know how many atoms are here?

St: +2

L: 2 atoms. So if you had to look at only 1 atom, I can take only 1 charge with me. I can take +1 with me and she can take +1 with her - okay? We are never separate, we are stuck together quite well here. Would you like to go back to your seat? You can go. (Lecturer holds onto student - much laughter). We are stuck together - she can't go alone because we are Mercury 1+. Are you happy now? Do you see it is easy when we have people to help us...

This data reveals a lively and participative explanation. Despite this, the concept of Mercury was not immediately understood by all the students and while viewing the video Ms Potgieter pointed out she had to re-explain the concept five times before the students were satisfied that they understood. Also she had felt that a student's input had finally enabled them to understand.

32. *L: I didn't answer his question actually, only much later. One of his*

buddies helped me ...

L: When I've finished this everybody was happy, because I used the association of how many negative ions will go with it, you see. Some of them somehow understood it better when I did it that way.

In the questionnaire and discussion I probed the students' attitudes to role play as I suspected that the L2 learners might be particularly intimidated, however:

L2 It's fine, I like to watch others role play, that's very fine - it makes it easy to understand.

L2 When you get back to your seat you think that was fun.

L1 She makes learning fun, makes it a lot easier and exciting.

L2 Like when she calls out a few of us to represent acids and other bases, it is fun but is very good help to me.

Thus the role play seems to be effective in relieving the tension and monotony of a lecture and in increasing understanding.

4.7 Pace

Flowerdew and Miller (1992), in research into lecture comprehension problems and strategies of mother-tongue Cantonese listening to lectures in English, found that subjects were unanimous in rating speed of delivery as the greatest obstacle to understanding. When questioned why this should be so, subjects referred to the great amount of processing required of the incoming data in a very short space of time.

I looked at this issue in the questionnaire and the results were most encouraging.

Question 9: Describe the pace (i.e. the rate at which the lecturer explains) in the lectures by ticking the appropriate box in the table below.

Total	*Too fast*	*Too fast at times*	*Just right*	*Too slow at times*	*Too slow*
65	*0*	*7*	*54*	*4*	*0*

Comments made by the students endorsed the results above:

L2 She assures we understand - not just rushing into finishing up. I think she is quite good at lecturing chemistry.

L1 Miss Potgieter is one of the few lecturers I understand.

4.8 Data from the questionnaires (Appendix H)

The data from the questionnaires yielded a lot more information than I had expected. I expected the students to be blasé and bored with the procedure; however, they appeared to take it seriously by frequently writing comments in the spaces provided, which gave me valuable insight.

The questionnaire also enabled me to select students for the focus group discussions and generated questions to be used in the discussion. Many of the responses and comments on the questionnaires were confirmed and elaborated on in the discussion.

Ms Potgieter was interested in seeing the questionnaires, which I gave to her to read through. She responded that she found the comments helpful, particularly one of the comments which suggested that a memorandum should be given out after every weekly test. Ms Potgieter stated that she was going to introduce this in 1996. She also asked if it would be possible

to use the questionnaire and adapt it slightly, instead of the traditional lecture evaluation form used by the Technikon, as she found the feedback from the questionnaire more useful and informative.

A summary of the information from the questionnaire follows, including some interesting comments made by the students.

QUESTIONNAIRE SUMMARY: LANGUAGE RESEARCH PROJECT (INPUT AND INTERACTION) COMPLETED BY STUDENTS.

NUMBER OF QUESTIONNAIRES HANDED OUT : 74

NUMBER OF QUESTIONNAIRES RECEIVED : 65

SECTION A: BIOGRAPHICAL DETAILS

5.	Home language	English	=	12
		Afrikaans	=	14
		Xhosa	=	34
		Eng/German	=	1
		South Sotho	=	1
		Tswana	=	1
		Northern Sotho	=	1
		Eng/Afr	=	1
				65

SECTION B: SUBJECT DETAILS

7. Matric symbol for Chemistry:

	HG	SG	
A	0	1	
B	1	5	
C	8	4	
D	12	9	
E	13	7	
F	2	3	
FF	0	0	TOTAL
	36	29	=65

SECTION C: LECTURE CONTEXT

9. Pace

Too fast	Too fast at times	Just right	Too slow at times	Too Slow
0	7	54	4	0

Interesting Comments made by students

L2 She is just perfect.

L2 She is a perfect woman for her job.

L2 Sometimes the lecturer is going much too slow but I think its because of the other students not knowing anything about Chemistry.

L1 and L2 She makes sure that we all understand before she passes that section of work. **(5 students)**

L1 Any slower and I'll fall asleep. However, Subject X is pretty fast at times.

L2 The rate at which the lecturer explains is right, but sometimes the lecturer is over-explaining things. To me the Chemistry lecturer is the best of them all.

L2 Spend a lot of time doing the same problem.

L2 She assures we understand - not just rushing into finishing up. I think she is quite good at lecturing Chemistry. **(2)**

L1 Miss Potgieter is one of the few lecturers I understand.

L1 I enjoy this lecture the most. I was never really interested in Chemistry until I started this course.

L2 It's okay because I never find myself behind or bored because of doing the same lesson/s.

10.1 **Role play**

Very helpful	Helpful at times	Makes no difference	Not at all helpful
38	23	2	0

63

2 students did not respond

—

65

Interesting Comments

(It appeared that some of the students - especially L2 learners - did not understand the term 'Role play' - this should have been explained in the questionnaire).

L2 Like when she calls out a few of us to represent acids and others bases, it is fun but is very good help to me.

L2 At school I wasn't good in Chemistry but now I can do it.

L2 I found my lecturer's strategies very helpful as I was taught to memorize at school not to understand. **(2)** Her strategies are very good to me, this can be proved, by my results. Standard 10, I've got E and now I'm getting more that 90% in my tests.

L1 It is and makes chemistry easy when she helps us remember by using things that we can relate to.

L1 I get no academic help there from but it does relieve the tension a little - makes it fun.

L1 Makes lectures more interesting but it doesn't really affect the understanding.

10.2 **Use of pictures, graphs (visuals) on the blackboard**

Very helpful	Helpful at times	Makes no difference	Not at all helpful
41	20	3	0

No response = 1

L1 It makes us look at the work in a totally new perspective. Makes learning fun!

L1 Use of pictures enables us to visualise the concepts being dealt with.

L2 She makes the lecture very interesting.

L2 The pictures are helpful when I don't understand something. (5)

L2 She loves pictures/drawings which are also helpful to clear out what goes on in a reaction.

L2 Because when you think about that picture everything come.

L2 We differ in understanding because pictures does not make something clear to me.

L2 I learn and remember things better if I hear and see it.

L2 They just summarizes everything and make it understandable.

L2 Sometimes the diagrams are confusing.

10.3 **Weekly tests**

Very helpful	Helpful at times	Makes no difference	Not at all helpful
52	11	1	0

No response = 1

L2 It helps you not to panic before writing a semester test.

L2 Helpful in terms that we know what to expect in the exam. **(5)**

L1 Helps to keep work up to date. **(4)**

L2

L2 The tests are helpful so that I can know where I am with my chemistry. **(6)**

L1 A memo should always come after a test so that we know how the lecturer wants the answers written.

10.4 **Re-explaining of difficult concepts**

Very helpful	Helpful at times	Makes no difference	Not at all helpful
54	9	0	0

No response = 2

Comments

L1 Most lecturers will not do this as they always say you not at school now, we won't spoonfeed you. They don't understand that they have been doing the same thing for years, us only once.

L2 Sometimes you become very confused of the explanation and when she re-explains it, become better example (solubility equibia).

L2 I also have a peer supporter so if the lecturer didn't explain clearly I go to

my peer supporter.

L2 Not all of us can quickly understand first time. She doesn't mind even if she could explain 100 times as long as you're going to get it at the end of the day.

L2 The lecturer must try to come down she flies too high.

L2 When you don't understand she always explain it so many times. **(2)**

L1 Vital for good results and the grasping of the fundamental concepts of that specific subject.

L2 Miss Potgieter explain something differently the second time. It helps seeing things in different perspectives.

L2 Sometimes I get lost and not know what to ask therefore when she explains again.

L2 Sometimes you thought you understood but all along you didn't.

10.5 Language modifications e.g. paraphrasing

Very helpful	Helpful at times	Makes no difference	Not at all helpful
32	17	14	0

(11 of these were L1 speakers)

No response = 2

Comments

L2 Helps you to understand some things that is not clear in English. (2)

L2 It helps when she writes words on the board for the spelling of it.

L1 I am English - doesn't effect me!

L2 She tries the best she can to make you understand.

L2 Some of us English is not our first language, so it is very good to do that.

11. **Do you feel comfortable asking questions in class?**

YES	NO	SOMETIMES
40	23	1

No response = 1

L1 The lecturer does not mind explaining again and she will not make you feel stupid.

L1 I know that how stupid/naïve my question is, the lecturer will still help me.

L1 The class is relaxed and not formal.

L2 Whenever you ask a question she tries by all means to make sure that you do understand.

L2 Everyone is free in chemistry class because the lecturer is also free with us.

L2 It is comforting to be a fool for one minute rather than for the rest of my life and not know the problem.

L2 I feel comfortable in class because the lecturer knows each and everyone in the class. I sit on the front seat which makes me feel comfortable.

L2 Asking questions in class play a role in my confidence.

L2 Because the lecturer doesn't become scared when we are asking the questions instead she's very happy.

L2 She attends to every question seriously and explain in detail.

L2 Yes, the lecturer talks to me on a very adult way. Do not feel threatened or simple asking a question.

L2 She treats students equally which makes me to feel free.

L2 She is so approachable.

L2 Because I say to myself, maybe other students understand this, so I'm wasting their time. I go to her afterwards.

L2 It is usually a mass lecture, so I get a bit shy, but I don't mind asking her. **(6)**

L2 The class is so full even though I am not shy it makes me feel stupid to ask.

L2 The problem is that I am not able to speak English properly and I don't like to be laughed at because of that. **(4)**

12. **Do you use your textbook regularly?**

YES	NO
48	16

No response = 1

(This question was of particular interest to the lecturer as she was not sure about the students' reaction to the textbook i.e. whether it was an appropriate choice and whether students actually used the textbook. She tried in lectures to help students to use the textbook effectively e.g. use of index, contents etc.)

4.9 Summary

In this chapter I have analysed the data gathered from the various sources mentioned in the introduction to the chapter. I have attempted to relate the theoretical discussion to the data and reach conclusions based on these relationships.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Comment on Research Findings

This study has revealed that Ms Potgieter is a lecturer who uses a number of input and interactional modifications in order to make the lecture content more accessible to the students. This has resulted in a very positive attitude in both L1 and L2 students towards the subject of chemistry and in a very positive classroom climate and rapport between lecturer and students.

Ms Potgieter seems sensitive to the linguistic and cognitive needs of the students. She also is conscious of affective factors and consciously tries to build up the students' self-esteem and confidence so as to encourage them to participate in the construction of knowledge. Thus she seems aware of the feelings of "dislocation" (Ballard 1984: 48) that students might experience by moving from a high school environment to a tertiary one.

Feedback from the students indicates that Ms P also appreciates the additional adjustments L2 learners have to make as they have to identify and meet local expectations often in an "alien culture with different norms of authority and relevance" (Ballard 1984: 49).

Perhaps part of her success lies in the fact that she makes explicit and public statements of the "ground rules" for her lectures. Very often, in a tertiary context the rules can vary both between disciplines and between individuals in the same discipline, leading to confusion and unease on the

part of all learners, but especially L2 learners.

In the following extract, Ms P makes it plain that interaction, particularly in the form of relevant questions, is always welcome:

Lecture one 31 January 1995

L: I want you to ask me a question if there is anything you don't understand.

Before the break

L: If any one wants to ask me a question come and see me now.

This allows the shy, reticent student the opportunity to ask a question in a one-to-one, and therefore less intimidating, situation.

Lesson four 13 February 1995

L: If you want to discuss anything about your tests or anything else, come and see me in my office [long explanation of how to find her office accompanied by a map on the blackboard].

Lesson 20 February

L: Come and see me I'll show you how to learn.

These ground rules appeared to be understood by the students, who commented during the focus group discussions that they frequently went to see the lecturer in her office.

L2 focus group discussion

L2 .... She is not a dominating person you can speak to her anytime even not in class, when she's in her office you can just go and see her and tell her your problems.

L1 focus group discussion

I: And if you don't feel confident enough can you get to see the lecturer?

S5: Yes, she always says pop into my office afterwards.

S2: She has actually even said, if I'm not there leave a note, she has a note pad on the door, she'll contact you if you leave a phone number.

S3: I've been. You know even if your one test was bad she shows you how you are progressing, she doesn't like say, like I went once to my Subject X lecturer and I said what could I do because I had like failed a test, so he said well like learn basically, obviously .... but he didn't notice that I had come up like 10% it was like she, like she would have noticed, she would have said you have increased, next time it will be 10% more.

Thus Ms Potgieter is perceived as supporting the learner and as being accessible to the students.

I acknowledge that Ms Potgieter's linguistic and academic background play an important role in the way she presents the subject content, but I also believe that her personality is an influential factor. Ms Potgieter's lecturing style is that of a "performer" in that she appears self-confident and likes to play roles and interact with the students in an open, friendly way. She also

uses a wide intonational range and makes frequent digressions where she tells stories; these are marked by shifts of key and tempo so that the anecdotes and asides contribute to the global coherence of the lecture.

Her style of lecturing is participatory, informal and conversational, which at first concerned me as I thought this style might cause problems for L2 learners, problems of a cultural nature, relating to the role and status of students and lecturers and the degree of deference accorded to them. Or the problems might be related to content - interactive lecturers blurring the more clear-cut structure of the traditional lecture monologue and preventing the NNS student from recognising the schema that underlies a lecture. However, these fears were soon allayed after spending time in the classroom and by the student feedback. And in this study interactive aspects of modification, such as repair, negotiation of meaning, confirmation checks tended to be effective in increasing understanding.

Another prediction that needs to be discussed is that after observing the chemistry lectures I thought that the L1 learners might have been bored by the heavy subject redundancy and could, in fact, have found the lectures tedious and boring. This was based on the fact that I expected them to have a stronger grounding in subject knowledge, having attended well-resourced schools. In order to gain more insight I asked the students about this directly in the L1 focus group discussion. These were some of the responses:

I: You don't find, as L1 speakers, that this becomes tedious or boring?

Sts: (Chorus) No.

S3: I find that it actually helps us because if you understand it the first time, every time she goes over it, it becomes clearer and you don't

have to go home and learn it. I mean you will learn it but every time she explains it you understand more.

These comments contradicted my prediction that the L1 learners might become bored and as a result lose interest and not attend lectures.

An L2 learner's response to the question whether they found the re-explaining of difficult concepts helpful, is very insightful:

L2: *Most lecturers will not do this* [ie. re-explain difficult concepts] *as they always say you are not at school now, we won't spoonfeed you. They don't understand that they have been doing the same thing for years, us only once.*

This data seems to reinforce the notion that if the lecturer uses the right kind of approach and focuses on meaning, it does not matter whether the learner is L1 or L2.

This has pedagogical implications for a multilingual class, and we need to consider whether the common-sense view that L2 learners are at a considerably greater disadvantage when it comes to learning science is overstated. Halliday suggests that while second and first language learners respond differently to scientific English, it is the same features of scientific discourse that cause difficulties to both (Halliday and Martin 1993). Also perceived as an advantage for L2 learners is the fact that Science uses other symbolic systems (as observed in the chemistry class), and is less heavily reliant on language than other disciplines, for instance, in the social sciences.

Ms Potgieter acknowledges that bilingual learners do have a linguistic advantage.

Extract from introductory interview:

20. L: *Yes. Sometimes they had both languages in one class when they did not have teachers, but kids don't have problems with languages in a dual medium school.*

Whereas in the high school environment Ms Potgieter could switch from English to Afrikaans in order to facilitate understanding, she is now faced at the Technikon with a predominantly Xhosa-speaking student body. As she is not proficient in Xhosa, she has intuitively adopted various other strategies to increase lecture comprehensibility, which seem to be effective in both the academic and affective aspects. Quotes by students on the questionnaire and in the focus group discussion support this view:

L1 st: I actually enjoy her lectures.

L2 st: I enjoy this lecture the most. I was never really interested in chemistry until I started this course.

L2 st: To me the chemistry lecturer is the best of all.

L1 st: If you enjoy your lecturing you do so much better - it's not on purpose that you do it, but it just comes out.

L1 st: Whenever I speak to people outside the Technikon and say that I am not enjoying Subject X and my marks are going down, they say well you can't blame the lecturer, but then how can I explain my marks going up in chemistry, it must have something to do with the lecturers.

I must add that all these responses were unsolicited in that nowhere on the questionnaire, and at no time in the discussion groups, did I ever ask the

question whether the students enjoyed the chemistry lecture nor did I ask the students to evaluate the lecturer.

One of the strategies that Ms Potgieter has developed and which I wish to comment on further, is that of role play. I found this strategy to be an innovative and intriguing dimension in the traditionally "boring" chemistry lecture. As mentioned in the findings section (4.7) Ms Potgieter uses this strategy because of the influence of a lecturer she had in her second year at university:

Extract from introductory interview:

L: *I had a lecturer in my second year at Varsity that helped me, that helped me, that made it alive like that. He used body language and us and whatever to explain the concepts, so suddenly, although you couldn't see the molecule, you could imagine more or less what it was like.*

Also when Ms Potgieter studied in Israel, she found herself in a "foreigner-talk" environment and she discovered that she had to use a lot of paralinguistics to facilitate understanding (4.7):

Extract from introductory interview

L: *... you don't have family there so you become family and there is not a very good communication, so you learn to communicate a lot of things with very simple language because you haven't got the vocabulary to communicate that. I think that taught me, because gestures and your body and your eyes, you can say so much. You can use a very simple word but you can add a lot more to it.*

This observation might suggest that an important aspect of a teacher's/lecturer's training is to experience what it feels like to be in an L2 situation.

From these experiences Ms Potgieter began to realise the value of this strategy, particularly for L2 learners. In the students' responses to the question on role play the word "fun" appears repeatedly:

L1 st: It is embarrassing, but it's fun.

L1 st: When you get back you think that was fun.

L2 st: And it is easier to understand what is going on.

These responses seem to endorse Vygotsky's notion (1978) that play can create a zone of proximal development for the child and very often the line of ascent from pretend-play to higher mental operations also holds true for these adult learners.

Another aspect of Ms Potgieter's lecturing strategies that I would like to discuss further is that of questioning techniques, as the ways in which questions are phrased are fundamental to obtaining effective responses. Although Ms P uses questions frequently during her lectures, perhaps she could use a wider range of questioning techniques (Ellis 1993). Halliday and Martin (1993) make the point that the language of science demonstrates rather convincingly how language does not simply correspond to, reflect or describe human experience; rather, it interprets or, as we prefer to say, "construes" it. They believe that a scientific theory is a linguistic construal of experience.

Thus, ideally, Ms Potgieter should pause longer after asking questions to allow students time to review what they have just heard and to formulate questions. Such pauses will provide a clearly signalled space for clarification requests and might go a long way towards helping L2 students to take the initiative in asking the questions they need to ask.

In the observed lectures the data revealed that students asked questions frequently, as did the lecturer. Perhaps the students felt comfortable to ask questions because Ms Potgieter spelt out the preferred ground rules for asking questions in her class. Also she did not discourage questions for fear that they might dislocate the lecture, which is often a difficulty for lecturers who wish to encourage questions and clarifications from the audience in the course of a lecture, but fear that a point raised by a student may sidetrack the speaker to the extent that the lecture loses its intended coherence and transparency.

An L2 student commented:

L2: *Because the lecturer doesn't become scared when we are asking the questions, instead she's happy.*

A reluctance to ask questions in the classroom is often associated with language difficulties and this is validated by four L2 learners' comments on the questionnaire:

> *The problem is that I am not able to speak English properly and I don't like to be laughed at because of that.*

So despite the positive affective environment and Ms Potgieter's approachability, linguistic inadequacies (real or imagined) still inhibit L2 students from participating in the discourse. I believe that a variety of

questioning techniques coupled with longer pauses might go a long way in encouraging all the learners to participate.

Finally, I want to comment on Brookes and Brookes's (1995) view that it is not possible to divorce the language and other symbolic systems from the development of the concept. Thus the formulation of the concept will initially be more controlled by existing thinking rather than by the thinking desired in the teaching. If the words and grammatical patterns used are unfamiliar and do not bring images and thoughts to mind, a point made by Ballard and Clanchy (1988) and Jiya (1993), then it is to be expected that the learner's initial thoughts will be particularly confused. An L2 learner will thus have, for a significant part, a different problem from the first language learner if the context is monolingual, in that she will have less in the way of ordinary language to relate to her common sense experience. Two potentially interesting thoughts follow:

Firstly, if the concept is approached in a purely linear way, without significant linking to a variety of concepts, then the learner's way of looking at the concept will very frequently dominate over the standard or required concept. Alternatively confusion will reign.

Secondly, for both L1 and L2 learners, it would seem that the best hope of establishing a sound and widely accepted concept is to provide a realistic change process which allows maximum interaction between lecturer and student, giving careful attention to developing precise meaning, and which uses as many links as possible. This would include the use of other languages, a point which was made earlier.

However, interesting comments in this regard were made in the L2 focus group discussion.

I : *... do you think that learning chemistry through the medium of English, now accepting that you are Xhosa speakers, has been a disadvantage - that you would have done better if you had been able to learn chemistry through the medium of Xhosa?*

S4: *Huh! Xhosa is very complicated and very difficult, I mean, I don't think someone will be able to explain chemistry in Xhosa. I would find it difficult. It is better in English.*

I: *Do you think it is because you learnt chemistry in English at high school?*

S4: *Most probably.*

These comments corroborate the point made earlier in Chapter 2 about the "foreign language context" as envisaged by Vygotsky: because English has ostensibly been the medium of instruction since std 3 in ex-DET schools, these students seem to have moved into "deep" language acquisition and are thinking and conceptualising through their L2.

Creating many links means that the concept can be viewed in relation to many other concepts, thereby gaining a different and maybe more helpful context in which a precise understanding can be reached. This point takes us back to the comment made about establishing categories in order to discuss the role of input and language in the construction of knowledge, and it reinforces the point that understanding is facilitated by providing appropriate contexts which lead to a precise understanding of words and concepts.

Ms Potgieter, it seems, builds bridges between the common sense experience and background knowledge of the individual learners, be they L1

or L2, and scientific knowledge, as well as bridges between ordinary and scientific language.

Also, the data reveals that Ms Potgieter has used various strategies to ensure that concept development is not approached in a linear way, in an attempt to help learners (both L1 and L2) move towards an understanding and development of scientific knowledge.

5.2 Case study research

Some of the problems experienced in this study have been discussed in Chapter 3 (3.7.4). I want to comment on my initial concern about the pressure to please which seems inherent in a case study involving researcher and subject and which I feared would "muddle" the findings (Cameron et al. 1993: 93). My other concern was of a more personal nature, as I found myself feeling beholden to Ms Potgieter for the time and energy she had to put into this study, and this made me feel uneasy and as if I wanted to compensate Ms Potgieter all the time.

My feelings endorsed Walker's view (1986: 194) that a case study is a social process "with consequences for the lives of those portrayed as well as for the reader".

However, these fears have diminished rather than increased with the passage of time as I have grown in my understanding of the nature of case study research and its implications. Also Ms Potgieter has remained utterly professional and enthusiastic in all her interactions with me, which has allayed my fears of feeling guilty about absorbing her time and energy. In addition the findings of this research have provided a wealth of pedagogical implications and ideas from which much discussion will grow.

In keeping with the requirements of democratic research I showed a draft copy of my research findings to Ms Potgieter. Her written comments are included in the Appendix section (Appendix K).

5.3 Recommendations

This study has reviewed input and interactional modifications in a multilingual chemistry class. Ever-growing numbers of people are studying at tertiary level through the medium of English as a second or foreign language. Since a major part of tertiary study remains the lecture - it has achieved what has been called "paradigmatic stature" as the teaching-learning activity of higher education worldwide (Waggoner 1984: 7 in Flowerdew 1994) - an understanding of how input and interaction modifications affect lecture comprehension can feed into ESL teaching methodology on the one hand, and learner strategy training on the other. In addition this can also be of value to content lecturers at the Port Elizabeth Technikon, who can incorporate these modifications into their own lectures to multilingual classes, with a view to making them more comprehensible.

I realise that the findings of this research raise many questions and more research is needed before we have a clear idea of what constitutes a successful second language learning context. A lot more information is needed - in terms of how a lecture is comprehended, in terms of what a lecture is made up of, and in terms of how the variable features of a lecture may be manipulated to ensure optimum comprehension - before meaningful statements can be made about many aspects of lectures which will have concrete effects on pedagogy.

I am also aware that an ethnographic description is not predictive but rather should produce retrospective analysis in the hope of drawing "large conclusions from small, but very densely textured facts" (Geertz 1973 in

Flowerdew 1994 p 196). Also that there is a need for an ethnographic longitudinal study, militated against in this study by the constraints of a half-thesis.

I acknowledge also that a study is needed which contrasts the very different contexts within which lectures can take place - e.g. interactive versus non-interactive styles, addressed to small or large group, in technical or non-technical fields - and that one needs to consider what are the effects of such variables on input and interaction.

Nevertheless I believe that content lecturers at the Port Elizabeth Technikon, and in fact all lecturers in tertiary contexts who are faced with multilingual classes, should be sensitised to the needs of their learners. I know we must allow for the fact that native English speaking lecturers will vary in their underlying sensitivity to and even interest in the comprehensibility of their input to non-native English speaking students, but as mentioned in the introduction, many of the lecturers at my institution lecturing to a multilingual student body, have already expressed interest in learning more about effective instructional approaches. These lecturers' concerns could be built upon in developing a collaborative dialogue with ESL lecturers and in-service professional development. At the Port Elizabeth Technikon the discussion might center on issues such as how input can be adjusted for non-native learners and how instructional activities can be organised so that they foster student-lecturer interaction and student-student interactions.

With Ms Potgieter's permission, we could use some feedback from the students in the video-tapes of her lectures as the data for a workshop to which lecturers would be invited, and thus in a non-threatening and collaborative way we could raise consciousness about shaping input and interaction. Perhaps we could highlight three aspects in which modifications can be made: linguistically, which would include speaking at

a slower pace with clearer articulation and with a greater degree of redundancy; rhetorically, including explicit marking of overall lecture structure and of salient points; and by drawing attention to the socio-cultural aspects, thus alerting lecturers to the need to avoid unwarranted assumptions of shared knowledge and to the risk that the use of cultural "insider information" will exclude NNS students. Thus lecturers should be prepared in two senses, that is, both trained and willing to realise that the key to successful explanation when addressing L2 learners lies in the selection of culturally accessible material and not solely in the presentation of "simpler" input.

Through this discussion valuable insights could be generated which would enrich the practice of all those involved by "designing out" likely causes of comprehension difficulty and by "designing in" mechanisms that will encourage students to seek remedies when communication fails or half succeeds.

APPENDIX A

I agree to be a participant in the study on English communication by Mrs Sally Potgieter, lecturer in English Communication. She will be sitting in on some of my lectures in Chemistry and they will be videotaped for her by the Media Department for transcription and use of data in her MEd in English Second Language thesis. I understand that my name will not appear in her study nor will her description of events in the classroom be such that I can be personally identified.

....

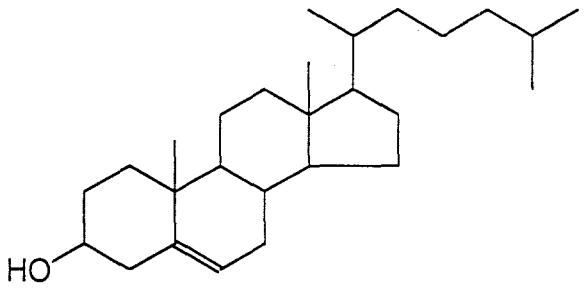
NAME DATE

EDITED TRANSCRIPTION OF INTRODUCTORY LESSON

THE PERIODIC TABLE

31 JANUARY 1995 - 08:10 - 09:40

L: L (*writes on board*): Buonis Dias!, שלום, good morning, molweni, bon jour, goeie môre, dumelang. (*Much laughter from students.*) Okay, today we are going to talk a little about language - you are going to start learning the language of Chemistry. Now in Chemistry, of course, you don't use normal alphabets and things like people in the world do - we use other things to show our formulae. Is this the language we use in Chemistry? *(Draws on board).*



What is this? Have you heard of cholesterol before? Ja sure that's cholesterol. But if I don't translate it for you, you won't know what this is. When I put these words on the board everyone was really surprised - you didn't know what was going on - so I put Xhosa for you because some of you understood what that word means and then I put English so that everyone knew what we were talking about or were there still people who didn't understand? Now what we are going to do in our Chemistry course today is we are going to start to learn how to name compounds - that is probably the most important thing and in this section of the work if you don't get full marks, you fail as far as I am concerned. So this is something

we must start working at, let's see if we can make some sense for you people. Look at the last page of your little bit of work I've given you. You are going to know that whole page off by heart by the end of two or three weeks, I can tell you, it will be easy as well. All right?

.....

(Handing out of consent forms by researcher).

L: We are going to try to make sense of this. What I can do is tell you to go learn this for Friday - but if you learn to put them in little groups then suddenly it starts to make more sense.

If you are going to work in a Chemistry lab all the bottles will have labels in English on them. You have to know the names of these compounds in English and people don't always use the same way of naming things. You see people did Chemistry in all parts of the world, some people did Chemistry in Russia, in America, South America in Europe and Japan - they gave different names to different things and then a while ago there were a lot of chemists who came together from all over the world and they had problems with the names because you come from Germany and you speak about a chemical compound and I don't know what you are talking about so they got together and they decided that they were going to give Chemical names to compounds and everybody must use it, but it doesn't work like that so unfortunately you will still have to learn for one compound a few names in this course. Next semester when some of you carry on with Organic Chemistry will see that it gets more complicated - you get one compound with four names and especially in industry, they don't use the names of the Chemical Union, they use the old names - so unfortunately you have to learn all of them but then you will be really good. What we will do first, we'll decide we are going to divide everything into three groups as

they have there on the paper. We have first of all positive ions - I'm doing this a little bit backward - do all of you know what an ion is? Must I explain what an ion is? Positive ion. Say for example my name is hydrogen - see my electron, I have only one electron, I actually like to give away this electron to someone else. Would you like to take this? *(hands piece of chalk to student).* Did you see it was easy for him to take it? I wasn't holding on to it - now inside in my nucleus I have a proton - that proton has a positive charge, this electron has a negative charge - the positive and negative cancel out, so I am neutral. When I give my electron to him what happens to me? Am I still neutral? No. I am positively charged. Is that right? So when we talk about and I actually don't like to take the electron back, I'm doing it now, but anyway. Positive ions are normally atoms that gave electrons to another atom or a molecule. They're the guys that like to give. You know in life some people like to give and others to take. Do you know people like that?

Sts: Yes?

L: Yes, we all know people like that. These are the givers, they like to give electrons away - we will talk a lot more about it later .

Now even the positive ions we can put into different groups - some of them have only one charge *(writes on board)*. Hydrogen is one of those - Hydrogen likes to give one electron away and only one electron and that's the only way you will find it. Other atoms might have more than one electron, some atoms may have two electrons, sometimes it gives away one electron, then it is +1 - sometimes it gives away two electrons and then it is plus 2 - so they don't know what they want. Some men say women are like that sometimes, they don't know what they want. Anyway, so some atoms may only have one charge and some may have two charges. (*Writes on board* *only one charge* / *few charges*).

Now, today on that piece of paper there are a few examples of atoms with only one charge, as we carry on with the semester you are going to add to the list. You are not going to learn all of them at once, that is crazy, all right?

(Writes on board below <u>only one charge</u>) One of them is hydrogen and the other one could be ..... sodium, another one is lithium - can you think of another one which would only have 1 charge - a little brother or sister somewhere? *(response from students)* Potassium, yes. Where do I find these type in the periodic table? *(Response from students)*. Group 1. Some of you might not know what Group 1 is. Don't laugh, there are some people that don't know. I don't have the periodic table, but once you have the textbooks I'll show you where you can find them. All right. If you go into the first groups of the periodic table most of those elements like to have only one charge - they give one electron or two electrons. Who are the guys who like to give away two electrons? *(Mumble from students).* I don't hear anything.

S: Magnesium

L: Yes, Magnesium, another one? *(Writes on board forming a table under heading <u>one charge</u>).* So when I say something has only one charge, it doesn't mean that they are all +1, it means it can only be +1 or only +2. It's not sometimes +1 and sometimes +2, right? So, Calcium is another one, so we can make the list very long. If these guys are not all on your list you can add them.

I'm going to rewrite this list so that they are below each other *(writes on board Hydrogen, Sodium, Lithium, Potassium, Magnesium, Calcium).* So when we want to name these things you give them the

same name as on the periodic table. So if that element is Hydrogen the positive ion will be Hydrogen and we will call it the Hydrogen ion. (*Writes on board $H^{\oplus}$ hydrogen ion, $Na^{\oplus}$ sodium ion, $Li^{\oplus}$ lithium ion, $K^{\oplus}$ potassium ion).* This will be a ..... sodium ion, lithium ion, potassium ion. This is an interesting one. Do you know what the K stands for? Why do we call this potassium and put a K there? That's a bit crazy. Why do we call that sodium and there's an Na there?

S: Other names also have the same letters.

L: That's a good way of reasoning, I think. I just told you a while ago that all over the world people gave names to things and the Germans did a lot of Chemistry - they had names for these things. So when we have a symbol it usually comes from the German name. In Afrikaans you will find some of the names to be the same as in German - because it is the same family of languages. But sodium is the English name, but I think the English had a different symbol for it, but Germans did so much more Chemistry that I think people decided to call it the German name Natrium - that's where the Na came from. But in English we call it sodium. Lithium is easy, that is the first two letters of the name Li. Potassium, the German Kalium that's where K for potassium comes from. Now if you know the story it may be easier to remember it. Okay?

You will find that the more you study the more German you are going to learn. When I studied Chemistry I had to take a course in German and in French, because in those days a lot of German people wrote down what they were doing in Chemistry in German so if I wanted to understand what they were doing, I had to learn German. You are lucky as the Germans have started writing in English today, so it is easy.

This one is Magnesium, they took the first and third letters. Mg. And this is Calcium *(writes on board)* - no you spell it like this - you must please correct my spelling. I am not very good - so sometimes the name helps us to remember the symbol and sometimes we need to know a little story, okay, everybody happy with that?

I am sure most of you have seen these signs before and you know them and you're thinking I'm telling you boring stories, but it's good to remember them. All right?

Now then we have compounds that have a few charges and there are two different names we can give them. I used to get very confused with this. So, today I have to teach you a little rule. One of the compounds that like to do it is Iron - symbol for Iron is Fe - do you know where that comes from? Doesn't come form German it comes from Latin, the Latin word for iron is ferrum - that's where the Fe comes from. Now Iron doesn't know what it wants to do. Sometimes it gives away 3 electrons and then it will have a charge of $Fe^{(+3)}$ - sometimes it gives away 2 electrons and then it will have a charge of $Fe^{(+2)}$. Do you see that I put circles around charges? You know why I do that? Because my handwriting doesn't always look so neat and when I start having with a negative charge, say a hydrogen with a negative charge, people may not see the negative charge so I put a circle around it so that they can see. I can give you a little tip if you want to make sure that I see the charge that you have put somewhere please put a circle around it because when we are in a hurry our handwriting gets a little bit worse, isn't that so? When I mark your test paper you are not there to tell me what you did so I must guess and I don't like guessing because I guess wrongly most of the time.

So Iron can be +2 or +3. Now the modern name is very easy Iron (III) - in brackets we put Roman numerals, that's the modern name for Iron. What will we call this one Fe^{2+} iron (II) don't put spaces in between. It's all one line - we put Roman numeral in a bracket that's the rule. So when I see iron (II) chloride I know the iron is 2^+. But in the olden days, they didn't do that, they used the Latin name and add a different ending - the Latin name is ferrum and they said for a low charge we will take first few letters and add an ous to it, ferrous, and the higher charge they called ferric, these are two endings that you are going to see a lot in chemical names. It will sometimes relate to a higher and lower charge this way and sometimes it won't. It doesn't always make sense - let's see if we can put it in little groups. All right?

So another one of these is copper. Now see if you can give names to these copper ions. Now copper comes from Latin again. Cuprum that's the Latin name for copper. Do you think you can give the two different names for that ion? See if you can think it up. If you are not correct that's fine. Write it down. The one on top I will say is Copper 2^+.

L: Copper 2^+. So you will write it like this and this one? (*points to board*)

St: Copper one.

L: Copper one. These are the easy names. Now what about the more difficult names? Latin?

St: The one on top I say is cupric.

L: Cupric. And the gentleman there, what will we call this one?

St: Cuprous.

L: Cuprous, that's correct. We call this cupric, this has a higher charge than that one. But that doesn't make sense - because here's 2^+ and this is ferrous and here's 2^+ and here's cupric. Sōmē of you are looking at me as if I am crazy, maybe I am a little bit crazy. Let's explain this. Ferrous has nothing to do with +2 and ic has nothing to do with +3. We use ic and ous when we have two ions - no matter what. You can have +4 or +5. The one with the higher number will always be ic and the one with the lower number will be ous. That's the rule. It has nothing to do with the number or the amount of positives. If I have two that are different, the one that has more positive charges will be ic and the one that has less positive charges will be ous. Right, are you happy? Should I do another one? Let's see if I can look at another example.

Let's look at that one, there's Stannous +2 and +4. Have you ever seen this sign before? Sn? Do you know what it stands for? Tin. In English we call this element tin, right. Now the Latin name for that is stannic. Sn that's basically where the symbol for that compound comes from. Now Sn is now different from iron and copper. We can get Sn 2^+ so how many electrons does tin give away? 2 electrons, and we can get Sn 4^+ how many electrons does this element give away? It's -4 electrons. It actually depends on who is around. If there is a greedy guy around it has to give 4. If there is a less greedy guy around it has to take two. Now what do we call these two ions. The easy English names would be tin 2^+ and tin 4^+. What would the more difficult or old names be? Go to the Latin. Which one will be stannous 2 or 4?

St: 2

L: 2 will be stannous. And this one will be stannic. Isn't that a bank or something? (*students laugh*). You can borrow money from these guys? Is that right? This guy only likes to give a lot of electrons - maybe that's a way of remembering it. So is this so difficult? No, it's not so difficult, but we must just try and find little stories to go with everything. Now on Friday you are writing a test on this - hey don't forget - before lunch.

Right let me see, in about 15 minutes we can take a short break. Now what have we done? We have done some positive ions - some of them are not particular they can either give away 1 electron or two, some of them don't know what they want, sometimes they give 3 or 2 or 2 or 1 - then they have to have different names - now we have to know a little bit of Latin as well. Does everybody have this down?

Can I clean the board? Have you got this down?

Now the other group of positive ions is when we have a couple of different atoms altogether. Here we only have 1 atom, we just have sodium and 1 sodium and here we only had 1 ion, now sometimes different atoms can come together and altogether they can give away an electron that gives a positive charge - so we have to look at those as well - that's the third group (*cleans board*).

Do any of you want to make a lot of money? Discover something that cleans a blackboard quickly. I'll buy it from you. So let's see what we have (*writes on board*), we had one charge - we had elements that could have more than 1 charge - now we are going to

have the third one that says polyatomic. What does that mean? What does poly mean?

Sts: *(Chorus)* Many.

L: It means a lot. Have you heard of polyester?

Sts: No (chorus).

L: It's some material you can buy. In the old days we used to have cotton which comes from a plant, so if you can't grow plants you think of something else. Polyester is the material that you buy - they mix it with cotton - now poly means a lot of what? Esters. Esters is not a lot of girls but is a type of chemical bond that you can form and in polyester there is a lot of ? Esters. You will learn about esters next semester. So polyatomic means I have more or a lot of atoms, normally different ones. Now the one that you might know and I was using it in the lab yesterday is this one *(draws on board)* NH_4^+ what is this called?

Sts: Ammonium.

L: Ammonium. Why do we call it ammonium? Because it comes from?

Sts: *(Chorus)* Ammonia.

L: Ammonia. What does ammonia look like, NH_3? It's a nitrogen with 3 hydrogens attached to it. It likes to take an H^+ so we can take ammonium that likes to grab a H+ - that's what I was doing - I had some acid in my reaction and I wanted to get rid of the acid so what did I do? Ammonium and then we get NH_4^+. Whoopsie, now most

of these polyatomic ions - there's not much logic behind them - you can only know this is ammonia because it comes from ammonia - you mustn't get confused with this - this one is ammonia without a charge and ammonium is with a positive charge. Now you are going to see this quite a lot - you are going to see a lot of ions like that, it doesn't always mean, it usually has to do with a positive ion, usually, - so when you see at the end of a chemical name or somewhere ium - you know for sure or almost for sure because there is always an exception that it has to do with a positive ion - that's a good tip sometimes, you might see a name that you don't know at all and when you see an ium at the end there must be a positive charge, right?

Let's see if there are any more of them? Yes (*looks at textbook/notes)* there are stacks of them. Let's take water H_2O - and we add an H^+ to it - what do we call that? Hydronium - does that make sense to you guys? - H_3O^+. Hydro - have you heard of those fancy places you go to when you are too fat and you feeling that you've eaten too much? You go to a hydro. A hydro - have you heard of that before - if you are not very rich you probably haven't - it's a place where you go where they have special swimming pools and people that massage you and you go on a special diet - no meat only vegetables and you do lots of exercises in water (floats on stage) it's call the hydro - I think it comes from water.

But now it's water with a positive charge, why does it have a positive charge? Because we added H+ to it - we call this hydronium and then we see the ium again. (*the formula is developed on the board*)

$NH_3 + H^+ \rightarrow H_3O^+$ hydronium - water with a positive charge.

Let's look at another one. Mercury. Now we are getting into a bit of trouble here. This can cause confusion if you don't listen carefully. This one actually fits into both of these categories. Mercury likes to be +1 and +2 and the symbol for Mercury is Hg and I don't know where the Hg comes from - so I can't tell you a story there. Right, Mercury likes to be +1 and +2. When it is +1, it cannot be by itself, it doesn't like to be by itself, it is like some people. Some people like to be with somebody, others like to be by themselves. Do you know people like that? Now, mercury +1 hates to be alone - we never find it by itself. So if I write this Hg^{+1} it is wrong because I will never find one of those by themselves - they will always come with another one.

So two Hg^{+1} will come together and what I must do is write it like this Hg_2. What does the 2 down there mean? It means I have two of these guys - 2 (*L points to hydrogen on board*) - another way of writing it is .... somebody said an atom could be represented by a little ball (*draws • on board*) let's say that is a $\dot{H}g^{+1}$. It can never be by itself. It will always take another guy:

($\dot{H}g^{+1}$ $\dot{H}g^{+1}$)

↓

$\ddot{\cdot}\cdot^{+2}$ they will come together and they will look like this. Now this one is +1 + this one is +1 what will this whole thing be?

Sts: +2

L: +2. You can write +2 or you can also write 2+ doesn't matter which way you write it. Now if the two mercuries are sticking together we always put the 2 on the right hand side at the bottom Hg_2. If you put the 2 in front it means we got two separate ones - maybe you should write this down - so we can say Hg+1 Hg +1

which one is the correct way to put Mercury? The bottom one or top one?

Sts: The bottom one.

L: The bottom one because they don't like to be alone - they like to stick together. So, if you want to write the two Mercury ions we write it like this, Hg_2 and here we write Hg^{2+} . So this is +1 - we have 2 positives, but we have 2 atoms - we can see it from here, two atoms come together to form one. Stuck together, they are not separate. All right? Must I explain this again? Okay. Mercury doesn't like to be alone ..... then you must come and demonstrate with me.

[2nd time concept is explained] Would you like to come here (*points to students in front row*) Who likes to act? I'm looking for a volunteer. Come on. Nobody wants to come. I can't explain on my own. (*students not establishing eye contact and giggling*). I won't eat you - I've had breakfast . You must come (*st in front row).* Now look at this *(points to pen)* she has even brought her electron with her. Now we are both Mercuries, we like to give one electron now we must give away our electron (*they both hand pencil and chalk to students in front row)* - she is +1 and I am +1 but we don't like being alone, we like to be together (*Lecturer links arm with student*) - when you see us what do you see? +1? You see +2. Do you know how many atoms are here?

St: 2

L: 2 atoms. So if you had to look at only 1 atom, I can take only 1 charge with me. I can take +1 with me and she can take +1 with her - okay? We are never separate, we are stuck together quite well

here. Would you like to go back to your seat? You can go. (*Lecturer holds on to student - much laughter*). We are stuck together - she can't go alone because we are Mercury 1^+. Are you happy now? Do you see, it is easy when we have people to help us. Thank you mam. Any other questions? Yes, sir?

St: (indistinct)

[3rd time] ***L:*** Is this the same as that? No, they are not the same. May I take everything off the blackboard. May I please start again? Okay. This is very important question this man is asking. Most people think they know but they don't know what is going on. (*cleans board which is filled with writing*).

Mercury Hg. I tell you we get Mercury like this Hg_2 and Hg^{2+} and people want to know if these two are the same. What does it mean if I have the 2 down there?

Sts: indistinct

L: It means that I have two guys stuck together and now it is very important that I have a picture in my head. Not the letters, that doesn't mean anything - I would see two guys stuck together like this $^{+1+1}$ each one would be +1- this whole thing together would be +2. How many atoms do I have here?

St: 1

L: Is there a number down there? No - so it means it is only 1 atom. (*draws • on board*). What is the charge in this atom? +2. Now I am going to tell you something else. This is my electron (*holds up a piece*

of chalk) - this electron is moving very fast around me (*lecturer moves arms and chalk in circles round body*) so it is using a lot of space around me. If I give it away, what happens? I am going to look a little smaller because this electron is not running around me. If I give away two electrons I will look even smaller. Right? Because if I have two electrons both arms have to move. Right? So which one would you think - this guy with the 2+ must be smaller than the one guy with 1+. Isn't that so? Okay. To make the difference I'll make this one a little but smaller . Does this thing $\bullet^{+1}$ and this thing $^{+1}\ ^{+1}$ look the same? (*points to drawing on board*). Do the pictures help? The gentleman in the nice checked shirt who asked me the question. Do you have the pictures? That's good. I think the picture is much clearer than this (*points to symbols*). So when we see this (symbol) in our head we must see that (pictures) as well. Yes sir?

St: indistinct

L: Excuse me.

St: ... two electrons get together how did you get the 2 at the bottom?

L: At the bottom? Hg_{2+}. Do you mean this doesn't make sense to you. Why is there one atom here and why is two here?

St: No at the top - two electrons - how do you get 2 at the bottom?

[4th time] ***L:*** Okay now. Mercury when it gives away one electron, right - how can I explain it? I need to find another way of explaining it. Let me think now. I think - .... I want to make the whole of Chemistry easier now so that you can try to understand it. Every element is like

a person, okay? How long does it take to really get to know a person - long time, is that right? Now when we study Science every element behaves different ways, all right. Now we don't - actually we are doing it all the wrong way around, you shouldn't be sitting in the class, you should actually be in the lab blowing it up in getting to know nature. But what I'm teaching you is what people notice when they start looking at mercury - they see, ah! Two of them are together and the charge is +2 but if they are separate the charge is also +2. So that is what they saw. I can't explain it to you but when one atom of mercury gives away one electron it has to find another as it found one here (*moves towards student who role played earlier scene*) Do you remember? It will never be by itself. If I have two electrons and I am mercury and I give them both away to somebody - I don't mind being alone. Now I can't explain to you why mercury does that. Do you sometimes like being alone, sir? Did that answer your question?

St: Yeh - sort of.

[5th time Mercury is explained]

L: Sort of. You must ask me to still explain if you are not sure. Will you think about it and come back to me?

St: Yes.

St: ***(Another L2):***What about looking at it from this point? Let's check (indistinct). So if it's true it may be (indistinct) with only 1 electron - so if it combines with another it is two electrons.

L: No, not necessarily.

St: Does it become 2+ if it gives away 2 electrons?

L: Yes, it becomes 2+ if it gives away 2 electrons, but now you can find this compound. Where's my electron? Let's look at Mercury combining with the chloride ion $Cl^{\ominus}$? We know that chlorine is a compound that likes to take electrons I like to say grab - in a swimming pool people like to put chlorine in it and sometimes you can also die of chlorine because if you inhale it dissolves your lungs - why does it dissolve your lungs, why does it damage you? Because it takes electrons from your lungs if it has to. Now when it has taken an electron - chlorine likes to take one electron and then it becomes a chloride ion $Cl^{\ominus}$? How does this combine with these two guys (*points to pictures* $^{+1}$ $^{+1}$) Let's first think of a picture - I need another colour chalk, but they haven't got one here.

Chloride ion takes another electron so it is quite a big story Right? It is -1. How many chlorides would go to this guy? Two.

I put the chlorides in front because I have two separate ones - what will it look like when they have combined? Like this. A small mercury in the middle O•O with the two chlorides and how would I write the symbol for this compound? $HgCl_2$. Now this 2 doesn't mean that the chlorides are stuck together it just means that they are part of the molecule and are sticking to something. Right. Here they are sticking to the mercury. What's going to happen if the chloride has to go with that guy? How many chlorides would like to go with this mercury? $^{+1+1}$ Two. Is that right? Because I have two positive charges - chloride is one negative charge so this negative charge would like to go with 2 positives. So again I have 2 $Cl^{\ominus}$could possibly look like this O••O with 2 mercuries always stuck together. Is it getting better sir, in the back there?

St: Ja.

L: Okay, just hang in there. I'm sure you will be the best one of these days. Do you want to write this down? Before we stop we must put little arrows. What would be the symbol for mercury? How many mercuries do we have? O••O Hg_2 - where do we put the two? In the front? At the bottom because they are sticking to something Hg_2 Cl_2 and how many chlorines? 2 chlorines. We are saying that we have a chemical compound that has 2 mercuries and 2 chlorides and somehow they are stuck together. We cannot say that the two chlorines are stuck together. Why are they sticking together? Because the mercury has a positive charge and the chlorine has a negative charge. They just love each other, they can't stay away from each other. You cannot say from this how they are stuck together. All right? Do the pictures help? I hope so.

All right we can take a break. Please don't be late you will miss some exciting things.

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EDITED TRANSCRIPTION OF LECTURE II

BALANCING EQUATIONS

TUESDAY 7 FEBRUARY 1995 - 08:10 - 09:40

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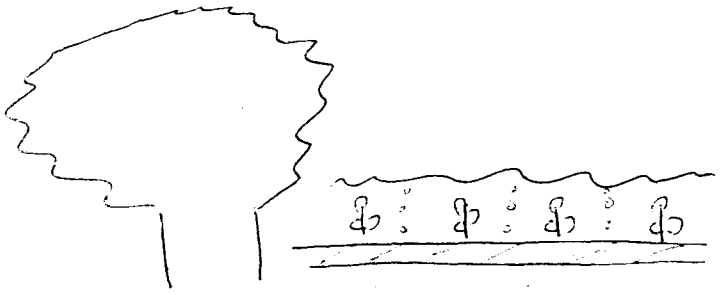
L: Let's quickly look at another reaction in our textbook. Let's take methane gas. $CH_4 + O_2 \rightarrow CO_2 + H_2O$ (*writes this on board*). Another word for it is marsh gas. Who knows what a marsh is? In more modern days we can call it something else - we can call it rubbish dump gas. Now when we have a marsh, it's basically a piece of land covered with water, but not a very thick layer of water - there are plants growing there. What happens at the bottom of this - it's not really a dam, it is really a vlei covered with water. (*draws on board*)



anaerobic (little oxygen)

At the bottom there is mud and stuff - and there is bacteria growing underneath there. What happens in this marsh - let's have a couple of plants and weeds - but down here is no oxygen - when there is no oxygen present we say it is an anaerobic situation - aerobic means oxygen, you know those exercises you do when you have to breathe a lot of oxygen? Anaerobic means little oxygen or no oxygen at all. Now these bacteria love it when there is no oxygen, but instead of exhaling CO_2 they breathe out methane which is quite explosive - it's related to those things you put in

your cigarette lighters. So what happens is the little gas bubbles come to the top and it's quite hot in these areas and the methane gas explodes by itself - so if you are on the marsh at night it is actually quite exciting because you sit and you see flames coming out all over the show - it's the methane gas that's coming out. That's about the only thing methane is good for and that is to burn. Methane reacts with the oxygen as it comes out of the water - comes to the top and it is very hot there and it reacts with the oxygen which is in the air (*writes on board*). $CH_4 + O_2 \rightarrow CO_2 + H_2O$ reacts with carbon dioxide to form water.

Now your body does a similar thing - instead of methane it uses sugar. You inhale oxygen - is that right? Now you don't have a fire burning inside of you everything is nicely controlled, but what comes out of your nose and mouth? Carbon dioxide and some water. You breathe on your glasses you will see they get misty.

Let's try and balance this equation. This is a very important type of reaction, it's just burning and today we use it a lot - in our cars and whatever. We just use the big brothers of methane - this reaction is called the combustion reaction and we are now interested in balancing it.

$CH_4 + O_2 \rightarrow CO_2 + H_2O$

Now if I look at a reaction I have to start somewhere. I count all my atoms - how many carbons, hydrogens and oxygens.

Let's have a look - how many carbons do I have on the left hand side here? (*writes on board*)

C 1

H 4

O

Sts: One

L: One carbon. Does that 4 have anything to do with the carbon?

Sts: No

L: No. It's only got to do with the .....

Sts: Hydrogen

L: Hydrogen. If I have one carbon here, how many do I have there?

Sts: One

L: One. How many hydrogens here?

Sts: Four

L: Four and over there?

Sts: Two

L: Two and oxygens?

Sts: Two

L: Two here and over here? Now I have a problem my carbons are balanced but my hydrogens and oxygens aren't. So, what one can do is one can draw pictures of these guys and maybe you can just add molecules. Let's make carbon white one carbon here and attached to it we have four hydrogens and oxygen we'll make orange.

1 carbon 4 hydrogen 2 oxygen 1 carbon 2 hydrogen 2 oxygen

C 1

H 4

O 2

You think it is boring to draw the pictures, but that is what it really looks like -- you have to have magic glasses - gives you a better idea. Now we have one carbon and it's attached to two oxygens - we have another oxygen here, it's the orange one attached to two hydrogens. Now let's have a look, I have 4 hydrogens here only have 2 there so I've got 2 separate ones left. What else have I got? I've got 2 oxygens here and here I see 3. So what can I do? Let's add another oxygen and see what happens. I need another one - isn't that so? All right let's immediately add another one - what will I get now? I'm going to have 4 oxygens. So 2 of them I have used already and this one is that right? So there is one left, where can that go? It can go in there. Everybody happy? So all the oxygens have been used 1 2 3 4. Let's look at the hydrogens - 4 hydrogens, 4 hydrogens, 1 carbon and 1 carbon. So I can look at the pictures and count if I add on this side if I had too many oxygens. I could have added another couple of things and I could have carried on like this until it is balanced.

This method that I am using, one can get a bit stuck in it - it can carry on forever, but with a little bit of practice you can sometimes look at it - but it is difficult for me to look at the equation and see what I must find. I like to draw pictures, all right, maybe I'm a kid still, I don't know. If I draw a picture it's easier for me to see what is going on. Now this method I used we say you balance an equation by inspection *(writes this on board)*. So what numbers must I now add in front of these things to make this equation balanced?

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

I've got one methane, 2 oxygens, 1 carbon dioxide and 2 water molecules.

I'm sorry if I'm boring you, but some of you never got this - they learnt it off by heart just learnt it to pass - because you can't learn it off by heart, you must try and see the molecules.

I have two separate guys each one has got 2 hydrogens and 1 oxygen - 2 hydrogens and 1 oxygen. Okay, so this is one important reaction and a lot of chemicals that are used in the world today are used up in this way - oil and petrol and coal and whatever - it's all combustion - all react with oxygen - it forms carbon dioxide and water and sometimes some other horrible products. All right? If you look at p70 in textbook - you can read about combustion.

.....

Has anyone ever told you how big an electron is? Take a rugby field or soccer field and make it round - that is the size of a big atom. Now the proton in the middle is the size of a pea in the middle of the field - you know peas - those round, green goodies that you have to eat because they are good for you, some of you don't like them - that pea in the middle of the soccer field is the size of a proton if the atom is the size of a soccer field. So what size is the electron? You divide by 1840 or something, is that right? If you were sitting on the side of the field with a programme telling who's playing and what position and that - look in your book can you find the letter in there - the letter i with a dot on top - the electron would be the size of that dot - electron is running around so fast in that space that it looks solid moving fast - but what does it tell me about an atom? Basically that it is space - so I can really draw electrons if I draw my atoms this size - you won't be able to see it.

.....

Before break

You are thinking how on earth am I going to remember all this. Well, the answer is to do lots of balancing equations, there are lots in the textbook. I think we must take a break.

Sts: Yes.

L: Think about it. Let it sink in, don't let it fly out of your head now. When you come back we'll add a little bit to it and then we have finished balancing equations. If you have any questions, come and ask me.

After break

L: Somebody came to ask me a question and I think it's a very good question. Because we think we know what is going on, but sometimes we don't really know. Somebody asked me why must we add 2 electrons. So I said if you are not sure to draw a picture

$\bullet\text{-}$ $\quad\rightarrow\quad$ $\bullet\bullet + 2^{e^-}$

$\bullet\text{-}$

I have two chloride ions - each has a negative charge - they now come together to form one chlorine molecule. I've got two electrons that must go somewhere - so this one is given away. So these two chloride ions, each one gives away its electrons to form a new molecule that is neutral and the two electrons come free so that the chromium can take it. Now this is, from our experience, where most people go wrong, they add one electron on the other side there, they don't think we have two separate guys each one has its negative ion. It looks very easy when I have it on the board here. If you are not sure, draw a picture, you can only do better, right.

.....

L: Mrs Potgieter how do I spell neutralise - with a s or z?

Sts: S

L: I don't know, as long as you understand the meaning of the word.

.....

L: I am going to do some exercises from the textbook with you so that by Friday by the test you will be experts. Are you interested?

Sts: Yes

L: Where do I look in the textbook? I want to do exercises on oxidation. Where do I look?

St: At the end of the chapter.

.....

EDITED TRANSCRIPTION OF LECTURE ON OXIDATION STATES

MONDAY 13 FEBRUARY 1995

.....

L: Who still has problems with acetate ions that I asked you about in the text?

L2 St: I do.

Sts: Yes.

L: I think we need to talk a little bit about those acetate ions.

.....

L: Any more questions about this? (*long pause*). No? I think you can do this now.

.....

L: These two mixtures form a self-igniting mixture. What does igniting mean?

St: Set alight.

L: That's right. Burst into flames. If you mix those guys they'll just explode. What will they form? Nitrogen and water.

.....

L: Do you know structures? Where can you find out what the structure looks like um? Where will you look? Who bought a book like this? You paid a lot of money for it, right? It must give you some info. How are you going to look for the structure of that compound in this book. You look in the back - it's called the index. See if you find anything there (*Gives them time*). You need the structure. You cannot do it without the structure. Is that right? (*Time to look - lots of activity.*

Students find index - look through it). If you haven't got a book, go to someone with a book and let them show you.

Anybody found anything? No .... Where did you look? Did you look in the index for nitrogen? Did you see some nitrogen oxides there? There's nitrogen dioxide they talk about and then they say oxides of nitrogen - and when you go to that page there's not a structure in sight - they give you formulaes so what? It doesn't tell you anything. So what must we learn? We must learn to draw the formula for that thing. Has anybody taught you how to draw formulaes before?

Sts: No.

L: No, we are going to learn that now. That's the next step.

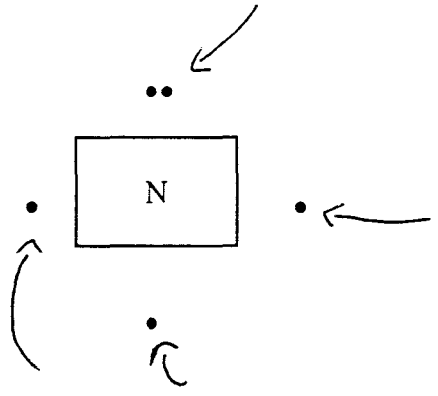
.....

L: This is probably for me the most important section apart from balancing reactions and doing calculations, that you are going to learn and that is Lewis structure - very important for us to know where the electrons are in the molecules. (*lots of talking among students - lecturer waits for silence*).

L: I'm going to have to ask some of you to leave this lecture if you don't stop talking. I hate doing that, but you are bothering me and the guys around you (*students quiet*).

.....

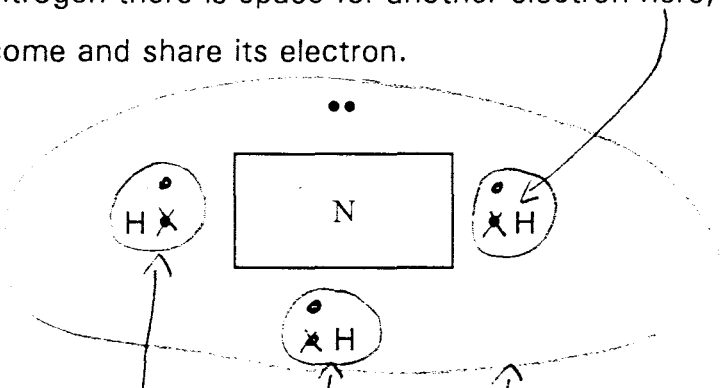
What we imagine is the elements in a little box (*Draws on board*). Each side of the box can have two dots on it. These two guys are together so they go on one side of the box here.



If you have three separate ones, each one will go here, here and there. Now this *(points to diagram)* is called the Lewis Structure. I don't draw the sides of the box, I have put it like this so you can see how they are arranged. You don't just sommer put them around this nitrogen anywhere you like - if I have two electrons together in an orbital they must be together on one side of this symbol as well. This tells me this Nitrogen has five electrons and these electrons can be given or taken or shared. Normally if you have one electron on the side it can share with somebody else for example Hydrogen. Hydrogen has only one electron. An energy level diagram of hydrogen looks like this. There is only one electron in an orbital. So I'll use another colour and say the Lewis structure for Hydrogen looks like this it only has one electron.

H

Nitrogen will combine with Hydrogen to form ammonia you have all seen this guy before NH_3. Let's look at the electron story. We see with the Nitrogen there is space for another electron here, so a Hydrogen can come and share its electron.



Another Hydrogen will say I'll give another electron, let's share and form a bond and another. Normally when we draw a Lewis structure of the way atoms combine, if we had to look at an element, say Nitrogen and we draw a circle around - they are usually 5, but they like to combine to form 8 electrons. Not all these 8 electrons belong to the Nitrogen - the Hydrogen does give some so that we can share - so there are 3 of these electrons that have been donated, so they are

sharing it. The Nitrogen is happy because it has 8 electrons around it. There is a rule in Chemistry, we call it the 8 electron rule, the elements like to combine in such a way that they have 8 electrons around them. The only exception is Hydrogen. Hydrogen will always like to have two. This is called the Lewis structure for ammonia, there was a chemist by the name of Lewis and he thought up these structures. We use them for a lot of purposes and they make our life easy.

.....

L: Read the Chapter on Lewis structures before tomorrow p. 260 - a good bedtime story - you're guaranteed to sleep like a baby after you have read it.

Sts: *(laugh).*

L: Chapter 8. Skip para. 8.2 it gets complicated then you won't fall asleep you'll start panicking.

Sts: *(much laughter)*

.....

EDITED TRANSCRIPTION OF LECTURE ON SIGNIFICANT FIGURES

20 FEBRUARY 1995

.....

L: But first we must look at the concepts

precision (*writes words on board*) accuracy

L: To some people like me, I'm not very good at English, they sound the same to me, right. When you think a little about the difference between them, when we make measurements in the lab we get an answer, and this counts for everybody, metallurgy, medical technologists - people's lives depend on it. What precision do you make a measurement with if you have to count red blood cells or how many bacteria is in this sample or whatever.

And you rubber guys, if you want to vulcanise your rubber and things, how much sulphur do you put in there so that you measure so that it is really accurate.

Now, accuracy I can explain like this. Say I wait to weigh off a certain amount of sodium chloride (salt). I want to weigh off 1,000 grams of salt (*writes this on board*). So I get a scale that can go up to 3 decimals or a balance, there are some of them in the lab. Then I go and weigh a lot of samples, but it's very difficult because maybe I have big pieces of salt there. Let's say I'm weighing some samples and I have a student weighing some.

Let's say [Person A] - (*writes on board*) - Person B are weighing some samples:

1,002	1,005
1,001	1,006
1,000	1,005
0,999	1,005
0,998	1,006

Let's look at these results what do we see? Which guys results are closest to what we want? A or B?

Sts: (*chorus*) A

L: A is much closer to what we wanted. We say that A measured quite accurately in the sense that he was the closest to the value that we want. But B was far away. Is that right? So A is closest to the value of 1,000 grams. So we say there was sort of a good accuracy - accuracy has to do with how close I am to the truth. A is closer to the truth than what B is.

Let's look at A. What is the highest value A got? And the lowest value? (*writes on board*) 1,002

0,998

0,004 - this is the difference between the highest and lowest value? Is that right? So this guy didn't have a high precision in measuring, in other words, he had a big range.

Let's look at B. What is the difference between the highest and lowest values? 0,001 (*writes on board*). So this guy is more consistent, he gets the same thing every time - so he is precise, but he is not accurate because he is not close to what I wanted. This doesn't really happen in life because if somebody is precise he is also usually accurate, but I gave two examples so you could see the difference between accuracy and precision. So accuracy has to do with the truth or the range?

Sts: (*chorus*) the truth.

L: The truth. And precision has to do with the ...?

Sts: Range.

L: Range. Right. Write the words down (*does this on board)*

accuracy = truth

precision = range

.....

L: Have you heard of ISO 9000. Today in many labs, if you look in the newspaper you will see that this laboratory is accredited, it has ISO 9000 accreditation. Algorax has accreditation and Volkswagen is trying to get it and a lot of companies in the world are doing that. If you do any type of chemical work, engineering, metallurgy, rubber, you must, every method that you use, you must write it up and say exactly how you measured; what piece of equipment did you use, how did you calibrate it so that if you do work for somebody they know exactly the quality of work you did.

It is becoming more and more important. We cannot export to companies overseas if we are not using ISO 9000 methods in the labs. And the labs up stairs we are working towards getting accreditation as well, so there are strict rules. All of us are going to have to do a test on how accurately and precisely we measure. And one of these days if you can't do this properly, you won't get a job where you need to measure or anything like that.

.....

When we talk about significant figures we can measure things in different ways. I am drawing (*draws on board*) a ruler on the board. Say

_____ = piece of string

0	1	2	3	4	5	6	7	8	9	10	11
cm											

I have a piece of string and I want to measure the (*draws length of string on board*) length of the string. Let's say it is in centimetres. How long is my piece of string?

St: 2,36

L: Somebody says 2,36. Any other offers?

L2 *St:* 2,25

L: 2,25 *writes these figures on board as students call them out.*

St: 2,22

L: 2,22 I heard

St: 2,4

St: 2,5

(*Much laughter from students as list grows*).

Now we have completely different values here - if I tell you that the value you are going to give me your life depended on it, if you get it wrong, you will die (*students laugh*). How accurately did you give that value you must think of the range, be sure that it fits into that range - can you give me a precise, accurate value?

Sts: No.

L: No, because the ruler that I used doesn't have any lines to tell me where I'm at, but I know it's between 2,0 and 2,5 is that right? So if my life depended on it I would say that the string is between 2,0 and 2,5 cm. (*writes on board 2,0 - 2,5)* somewhere between there. If I didn't have lines in the middle between 1 and 2 and 2 and 3 then I would say between 2,0 - 3.

When we look at the values people gave to the piece of string, some guessed up to the second decimal. Do you think that is very accurate? Not even that, is that right? Between 2 and 3 is quite close to the truth. If I go to 2,0 and 2,5 I am getting closer maybe to the real value. If I go to 2,2 and 2,3 it is getting a bit shaky, I could lose my life here. Are you all with me? So when we make a measurement in science we often use different

equipment in running an experiment. I can maybe say this string is 2 centimetres long, plus or minus.

(*writes on board*) $2,0 \pm 0,5$

or $2,0 \pm 1,0$

L: You know when you go into decimals you are not so sure.

St: $\pm$ 1 gives you the range. The -1 could go the other way?

L: Could go the other way. What do you think would be a better way? $2,5\pm$

St: No.

L: $2,2\pm$

St: Yes, that's better.

L: Okay, let's do it like that. Take somewhere close to there. 2,2 plus or minus?

(*Writes on board 2,2 $\pm$?)*

St: $2,2 \pm 0,4$

.....

INTRODUCTORY INTERVIEW

TRANSCRIPTION OF REPEAT INTRODUCTORY INTERVIEW WITH MISS P ON THURSDAY 11 MAY 1995

1. *Interviewer (I)* Seeing that we are repeating the interview I thought that we could be a little more focused the second time around. If you could give me your autobiographical details in terms of schooling and tertiary experience and where you are now in terms of your academic career.

2. *Lecturer (L)* Okay, I was born and bred in the Free State and I spent three years in the USA with my parents before I went to school speaking only American - I didn't want to speak Afrikaans even to my parents. Then I went to school in Bloemfontein - to an Afrikaans medium high school.

3. *I.* Did you start sub A ....

4. *L.* Yes. I started sub A in the Free State, did everything in Afrikaans; did my BSc in Chemistry and Microbiology at the University of Bloemfontein and Honours in Chemistry at Bloemfontein University all through the medium of Afrikaans. Then I went to Israel and did my Masters in Chemistry through the medium of English.

5. *I.* What institution did you study at?

6. *L.* At the Weitzmann Institute.

7. *I.* How did you land up there?

8. *L.* It's one of the 5 best research institutes in the world and they have an exchange programme organised by the friends of the Weitzmann Institute in South Africa which is part of the Zionist Federation, and they sponsored, in those days - I don't know if they still do it - they sponsored for a few students from South Africa to go and work there for a few months. I went on that exchange programme and applied to be a master's student there. They accepted me and I stayed there for 2½ years.

9. *I.* So your whole career was academic - up till then you hadn't taught?

10. *L.* Yes. I had just been studying all the time. In my Honours year at Bloemfontein we started 'Love Chemistry' in our reses. We thought we would take the first years in hand because chemistry is often a nightmare for first years, so we thought, you know, we would support them and encourage them and whatever so that they can see that chemistry is not that bad. So I was always available if people needed explaining and that ....

and my little brothers and sisters of course as well, at school and that - you can always help.

11. *I.* And then back from Israel here?

12. *L.* Nee. Then I lectured at UPE for two years and then I did an HDE and taught high school Science for three years.

13. *I.* Was that at Pearson?

14. *L.* Yes, at Pearson.

15. *I.* Did you do your HDE while you were teaching at Pearson?

16. *L.* No. I resigned and was a full time HDE student.

17. *I.* You took a year off.

18. *L.* Yes, very exciting, I sat in the class with my old students. And then I did three years at Pearson teaching Science in English and Afrikaans.

19. *I.* Dual medium?

20. *L.* Yes. Sometimes they had both languages in one class when they did not have teachers, but kids don't have problems with languages in a dual medium school.

21. *I.* So what year did you start at the Technikon?

22. *L.* Now you ask me. 1992 - 93 - 94 .... at the beginning of 1992.

23. *I.* Beginning of 1992. So you taught chemistry here?

24. *L.* Mainly Organic chemistry and General chemistry for first years.

25. *I.* Through the medium of English?

26. *L.* Ja. At UPE I also taught through the medium of English.

27. *I.* Okay, thanks. That's your background in a nutshell. In fact, I remember quite a lot of it. Right, we have talked about the fact that we are faced with multilingual classes and that you have developed certain strategies that make chemistry more accessible - what you do, what you do ....

28. *L.* Yes. chemistry traditionally has been taught often as something you learn off my heart, just millions of formulaes. The lecturer would stand in front of the class and write things on the board or give you thick notes and

then you just have to learn - there is no reason, sometimes there is but for lots of people it's always been like that. If you really think of chemistry it is the behaviour of small particles - molecules and atoms, so if you can imagine what these things look like and start to learn their characteristics, like people, it is much easier to understand. If you can form some association, not just an abstract formula on the board - you must picture them in your head.

I had a lecturer in my second year at Varsity that helped me, that helped me, that made it alive like that. He used body language and us and whatever to explain the concepts, so suddenly, although you couldn't see the molecule, you could imagine more or less what it was like ....

29. *I.* Was he the first person who taught you like that?

30. *L.* Yes, ja and then I really started understanding Organic chemistry although I, I almost failed it in my first year - sort of got through with inorganic and other marks which you could learn and sort of get through on. Suddenly it was all alive. Now when I think of a molecule, I see it. You have to see in three dimensions which is not always easy. You must be able to turn this thing round in your head and be able to look at it from different sides and that is what my side of chemistry is all about - to see something in a molecule which nobody has seen before, to really look creatively and um, that was um and then I started thinking, how do I actually bring this across to the students, because we often think that this is what students have in their heads, but when you get feedback you get the opposite or get something completely different or you emphasize things but they actually picked up things that were completely different or were not that important? So I think all the time - I don't really sit down and prepare, but whenever I wake up at night or am walking, thinking, what can I use to explain, what association, what picture to explain this thing that will crop up in a lecture or I am going to teach. They need a good foundation so that they understand easily and quickly without misconceptions - this is a very big problem in our subject as well.

31. *I.* To try to get them to form the concept.

32. *L.* Yes.

33. *I.* Now do you think that these strategies that that you um er use, do you think that er because the learning is mediated mostly through language, do you think that these strategies would overcome any kind of barriers that language could perhaps .....

34. *L.* I am not always sure, because a lot you don't even learn in language.

35. *I.* It's doing it through pictures and diagrams?

36. *L.* It's problems, its Mathematics. So, the only thing where I think where language - now if the student has a picture, then he can translate an question in language into a picture, I emphasize that. So, you have a question in English that says so many sodium hydroxides ditrated with this der der der der and what is the molarity in the end. Now what I find even with first and second language speakers, even more difficult for L2 speakers, is they read the problem and don't understand what is being asked and now I try to teach them skills to read that. And I say now draw a picture of this, here's your flask with sodium hydroxide, do they tell you anything about the concentration, okay, so now write it down. Now take this and add stuff to it, then you draw them, so when you visualise then often before you have finished with the picture you know what the guy is going to ask you. Because if you really think what chemistry is, you work in a lab always adding things. You must be able to calculate or find out how much of something is in there and why it behaves in the way it does. One teaches through the medium of language but in actual fact it is things that you are handling all the time and I said to my students the other day I feel we are teaching chemistry to them the wrong way, we shouldn't sit in a lecture hall and talk about molecules and atoms when they can't actually feel and touch it. They should actually, the ideal thing is to be in the lab and to demonstrate and to get them to do things and explain the theory at the same time. Here's the stuff, let's see how much is in there, even then you might need little models and often then you don't need fancy language or anything to describe that - a few words or gestures or you could use sign language basically ....

37. *I.* .... because the difficult terminology you would have unpacked and sort of explained to them.

38. *L.* I don't like to use fancy words, I use very simple terms, for example we have some atoms that like to take electrons. So take is now an easy word. Scientists would rather talk about acceptor, electron acceptor or an electron donor. Donor, a lot of people don't know what a donor is, so I say a giver - somebody that gives. Donor is a fancy word for giver so I sort of teach synonyms and stuff, but it gets more complicated. A guy that gives electrons we say gets oxidised, but then that thing is a reducing agent. Now it's all just words that actually mean something. Then I try to explain it, maybe through association with it and use things to explain so that they can actually see what I am talking about. You don't actually know the meaning but you can figure all the words out. You don't have to go and learn if something gives it is oxidised and is a reducing agent, you don't have to learn that, because if you understand what the word means you think it up and actually create the concept and that's really what I want to get at, because when they know they do not have to bother about learning like a parrot, they can actually create it. Then they become creative scientists and they are not scared to try something new or they will have the confidence ....

39. *I.* You don't think because it is not your mother tongue through which you are teaching that has made you devise these ways of looking at Chemistry. I am just thinking maybe a lecturer who has only taught first language speakers, who studied through the medium of his first language, I mean, he would not expect that class not to understand.
[indistinct]

40. *L.* ..... learnt in the States, I was in standard eight coming from an Afrikaans school where English was my second language and we had vocabulary classes. Every week I learnt 20 new way-out words. Every class had a thick Webster dictionary, you know those Webster dictionaries? Well, we were given these words and we had to go and find out the meanings and then we were tested.

41. *I.* Did you find that this helped you?

42. *L.* It did, it really did. You can be much more expressive if you, like in the English language, I believe Arabic is worse, we might have one word, they will have 20 different words for the shades, nuances of that feeling or whatever. You can express yourself more accurately if you have a bigger vocabulary. Then I realised how limited my vocabulary really was. I still find that with first language speakers, I think my English is very simple and a lot of the bigger words, I still find English speaking people use words and I don't understand what they say, but I don't need those words to teach my subject properly. I think that could have influenced that because I think I am aware of vocabulary and ....

43. *I.* ..... levels of meaning ....

44. *L.* .... it was that but also living in a student community where there were a few people who couldn't speak English very well and we were like family to each other. You don't have family there so you become family and there is not a very good communication, so you learn to communicate a lot of things with very simple language because you haven't got the vocabulary to communicate that. I think that taught me, because gestures and your body and your eyes, you can say so much. You can use a very simple word but you can add a lot more to it. That taught me a lot. I don't think about it really, it just happens.

45. *I.* It must be a growth thing because I'm thinking of other lecturers who wouldn't understand that students wouldn't understand. You know, words like donor or recipient could be a barrier .... they don't share the same frame of reference ...

46. *L.* I've found that a lot of first language people, I worked at a school that had enrichment classes for DET matriculants, I've often had to go to my L1 colleagues and ask them, do you mind speaking a little bit slower because

you use, because your sentence constructions are quite complicated and if you speak very fast, it's lost? What you are trying to say, your ideas are brilliant, structure is brilliant and your demonstrations and everything is excellent, but first language lecturers tend to speak very fast, they start swallowing their words and they use complicated sentence structures, you know. I also realised that when I lived in Israel when I started learning Hebrew. I could get along quite well with the man on the street for example I could have a really good political discussion with a taxi driver on the way to the airport or whatever, using very simple language and then I met a doctor and she invited me once to have supper with her and her husband and children. They were much more upper class people and I couldn't understand, I couldn't follow the Hebrew they were speaking, the vocab was so much more developed. I had an idea where they were going but I couldn't follow whereas when I was sitting with the cleaners that worked with me I knew every word they were using. I followed them, I could speak with them and joke with them but I couldn't sit with the intellectuals and speak Hebrew and then I couldn't follow them.

47. *I.* It is quite interesting because in second language acquisition they talk about two skills, BICS, Basic Interpersonal Skills and CALP, Cognitive or academic skills and they say that people can, like I can cope in Afrikaans on the academic level but I can't cope on the interpersonal level.

48. *L.* I think it is your experience.

49. *I.* Ja, it's my whole experience. I've never had to use Afrikaans on an everyday level, for example to get to the station.

50. *L.* You don't sit and talk everyday talk - bietjie koffie and things like that ...

51. *I.* No, I don't interact on that level and it's quite interesting the paper I was reading yesterday says that's what you are, a language teacher for example by explaining words to teach concepts you are teaching language.

52. Sometimes it is quite shocking to me when they start writing these plat English words in tests as answers, you know, this guy grabs an electron; this guy is the best electron grabber of the whole lot (ha ha).

53. *I.* Do you have to iron this out?

54. *L.* No, I mark it correctly because they understand, that's what I'm testing, but I say to them, look guys, I did this because I wanted to explain it, but if you have to explain to someone else you have to use the words that they can understand, they are not so clever to understand your language. Also if you read in the textbook you might get into a tizz, textbook doesn't use the words that we are using. The scientists, because they try to look a little

more intellectual than they really are, that's what I tell the students, they try to look fancy and make it look difficult so they use these words. It is important for me that you also understand those words so that you know that it isn't so difficult and even when I explain this is what the word means and this is how you would write it in chemistry language.

55. /. That's great. Thank you. Because remember, the purpose of this interview, if you remember, was for us to discuss what you do in the class and then for me to sit in some of your classes and then for us to look at a video together. After that we will get some feedback from the students. That's great. Thanks once again.

APPENDIX G

TRANSCRIPTION OF REPEAT VIEWING OF VIDEO WITH MISS P

18 MAY 1995

1. Interviewer (*I*) Thank you for being prepared to do this again. I know how pressed you are for time at the moment.

2. Lecturer (*L*) That's fine.

3. Interviewer (*I*). I'm going to show you the tape of your first lesson with the students. I'll ask you questions every now and then, but I'd also like you to stop whenever you'd like to say something. I'd like you to focus on input and interaction, so whenever you want to explain why you did something in a particular way, please comment freely.

4. *L* Okay.

5. *I* Would you have started like that, I mean your first lesson if I wasn't there?

6. *L* I don't know. I take it as the mood .... it influenced it probably.

7. *I* Because that was the objective of the lesson - the language of chemistry.

8. *L* But, I've never done that thing before - I just thought it up. You could have influenced it - probably you did. I tried to get something that would fit in, ja.
(Lecturer amused by video and laughs and giggles a lot).

9. *L* The objective was to teach them the table. They need to learn the names of compounds - every compound has a name and they must learn how to name it, that's what I'm after. It felt so strange that first day, they're all so new, you don't know how things are going to turn out.

10. *I* When you give the name for the compound you try to give some kind of ....

11. *L* .... of association or whatever, but I think we are going to get to that just now (heh heh). I've never had such a big class here.

12. *I* And that makes a difference in terms of interaction because ....

13. *L* It makes it more difficult, they don't really talk, you don't really know if you are going to get something out of them. You use a lot more energy to get something out of them. (Watches video).

I'm trying to get them to relax a little bit. (refers to derivation of names for compounds) I chose the system because it makes it more simple because it puts things in groups. I start with this because they need them in other subjects.

14. *I* Do you think it makes it easier to put things in groups, is it easier if students can classify.

15. *L* Especially with that (*positive ions being put into groups*). Then they know that thing in context with all the other compounds or you get confused. I try to help them with their other work as well ....

16. *I* ... to see the connection?

17. *L* You must have a picture - it's an association basically to let them see something that could be quite abstract.

I should get myself some outfits to wear. Don't you think?

18. *I* For the video?

19. *L* No for this lesson. You teach them that you stay one person, on the outside you look like someone else - I could get an Alex J outfit or whoever is the star at the moment, like Jack Nicholson, brylcream my hair, you know, put on glasses - do something to look like someone else so that they understand you are still you, but you are always trying to look like someone else. And this is what the elements try to do all the time and you can predict their behaviour, by that you see who is the nearest snob, that's what I'm trying to tell them - you take off some clothes and you add some clothes so you look like the snob.

20. *I* This feeds into your idea of trying to see into the .....

21. *L* They must have a picture .... I think I'm going to do that next term ... I must get some nice clothes.

Do you see that they are talking? I didn't expect that the first lesson, not knowing any of them. You can see some of them are checking me out. (heh heh)

22. *I* What I like is the reference to the wider world of chemistry.

23. *L* You know the history is so interesting. There are so many incredible stories - it excites people, a bit, you know. I've read a lot about the history of scientists who made big discoveries - their lives and what kind of people were they. I have a few stories like that that I keep up my sleeve. Sometimes when you see the people are not there you tell them a story, to the point that last week they didn't want to work and said Miss tell us a story (laughter). Come on!

---

24. *L* I've told them they mustn't panic in chemistry.

25. *I* Especially students who are insecure in a tertiary environment.

(*Video deals with the teaching of Mercury*).

26. *L* You see, she's thinking how am I going to explain this? That's what I'm thinking. You see I am touching my nose - she's not quite sure how to do this yet.

The other day when I did um precipitation I said the one ion sees the other ion, they can't keep their hands off each other and fall to the bottom (giggles). They were screaming and they won't forget.

27. *I* I notice they like the pictures.

28. *L* They must see a picture - it helps. I can't just talk, they'll fall asleep.

(2nd time the lecturer explains the concept of Mercury)

29. *L* You were late, my dear. She doesn't sit there anymore, she sits towards the back and is on time. Shucks, after that who cannot understand it, you see? But you can't say that because they have certain associations of that concept, what they have learnt before and if you can't fit this in there they don't understand. The next few times some of them will contribute and say you talk about it like that, they help me along, they actually did and then I realise they want to put it in context with the negative ions that go with it. We'll see just now. I haven't thought of it like that, I only thought of it now.

30. *I* So the knowledge they bring with them .....

31. *L* Ja, pre-knowledge is very important and sometimes it's not just your explanation, it's also whether they can fit in with things that they already understand. You discover a lot of misconceptions.

(*Third time Mercury is explained. Lecturer uses a lot of role play and body langauge*).

I've had 200 DET matrics and I have the guys up their with their electrons. They just love it, it's the best, they can't get enough and they move, hey.

We are not shy, hey?

(*Fourth time Mercury is explained*).

32. *L* I didn't answer his question actually, only much later. One of his buddies helped me. I'm telling them a story but it's not really what he asked.

(*Fifth time Mercury is explained*)

When I've finished this everybody was happy because I used the association of how many negative ions will go with it, you see.

Some of them somehow understood it better when I did it that way.

APPENDIX H

QUESTIONNAIRE: LANGUAGE RESEARCH PROJECT

A case study of input and interaction in a multilingual chemistry class at the PE Technikon.

(Please respond to the following questions. Remember that honesty in responding to these questions is vitally important).

SECTION A: BIOGRAPHICAL DETAILS

1. Name: . . . . . .

2. Diploma for which you are registered: . . . . . .

3. School attended: . . . . . .

4. Did you proceed to the Technikon directly after matriculating?

YES	NO

If not, please give the details.

. . . . . .

. . . . . .

5. Home Language: . . . . . .

SECTION B: SUBJECT DETAILS

6. Grade of Chemistry studies at school?

HG	SG

7. Matric symbol for Chemistry: . . . . . .

8. Medium of instruction (ie. Language) through which Chemistry was taught at school:

. . . . . .

SECTION C: LECTURE CONTEXT

9. Describe the pace (i.e. the rate at which the lecturer explains) in the lectures by ticking the appropriate box in the table below. Please supply any additional information in the space provided below:

Too fast	Too fast at times	Just right	Too slow at times	Too slow

Additional comments: . . . . . .

. . . . . .

. . . . . .

10. Some of the strategies the lecturer uses during a lecture have been listed below. Please rate these strategies in so far as they help you to understand the subject by ticking the appropriate box. Please supply any additional information in the space provided.

10.1 Role play.

Very helpful	Helpful at times	Makes no difference	Not at all helpful

Additional comments: . . . . . .

. . . . . .

10.2 Use of pictures, graphs, tables and diagrams (visuals) on the blackboard.

Very helpful	Helpful at times	Makes no difference	Not at all helpful

Additional comments: . . . . . .

. . . . . .

10.3 Weekly tests

Very helpful	Helpful at times	Makes no difference	Not at all helpful

Additional comments: . . . . . .

. . . . . .

. . . . . .

10.4 Re-explaining of difficult concepts

Very helpful	Helpful at times	Makes no difference	Not at all helpful

Additional comments: . . . . . .

. . . . . .

. . . . . .

10.5 Language modifications eg. paraphrasing and repetition; simplification of vocabulary.

Very helpful	Helpful at times	Makes no difference	Not at all helpful

Additional comments: . . . . . .

. . . . . .

. . . . . .

11. Do you feel comfortable asking questions in class?

YES	NO

Please explain your answer: . . . . . .

. . . . . .

. . . . . .

12. Do you use your textbook regularly?

YES	NO

Please explain your answer: . . . . . .

. . . . . .

. . . . . .

TRANSCRIPTION OF INTERVIEW WITH L2 SPEAKERS

I: I am doing some research into language. Miss P agreed to participate so I had an interview with her and I sat in on your classes and now I would like to discuss your perspectives. The idea is that you are all second language speakers of English that is why I chose you okay, it is totally confidential, the fact that I have your names, I took them for the questionnaire - but we are not going to worry about names and who says what. It is not an interview, it is a discussion so it is not as if there is a right answer so I would like you to talk a little bit about what happens in the chemistry class so that I can know what your perceptions are. Tomorrow I am meeting with another group - all first language people, so that's the only difference between the two groups okay. Sipho is going to record the information, he is going to videotape it for us - I thought it would be easier than a tape recorder in the middle. If you want to see yourself on the video you are more than welcome. How am I going to report it? I am going to write it in a thesis which is going to be part of an MEd which I am doing. I am quite happy to give you copies which I hope to write by the end of the year. Okay? Would anyone like to ask any questions? Is there anything that worries you or that you are uncertain of? I thought we should ... I thought I should ask you this question and you must just chip in. I don't want to dominate - I'm tired of hearing the sound of my own voice.

I want you to think about the lectures you have in chemistry and to tell me what is different in chemistry lectures from other subjects? Is there anything different in the way that chemistry is taught from your other subjects? Think about it for a few minutes.

Silence.

St: In chemistry class there are so many, sometimes one doesn't feel *very* comfortable to ask the questions, because if you ask the whole class ... *quietly spoken*

I: Would you feel more comfortable in a smaller group?

Same

St: Yes.

I: Are there times when you feel you would like to ask questions?

Same

St: There are.

I: But you never ask. And the others? The girls?
(Interruption as three students arrive late for discussion)

I: Is chemistry easier or more difficult? Would you like to say something about that?

St2: *(indistinct)* She uses a lot of drawings in the classroom.

St3: ... she understands our point of view ... and she explains that it means that in that context. I think she understands our problems with second language.

I: That the words might be a barrier to meaning. I think that is quite an interesting point that she is not English speaking. Does she ever tell you this?

Sts: *(chorus)* Yes.

I: Would any one like to add anything else? There was a contribution about drawings on the board.

St2: Yes, the pictures help us.

St4: She makes you feel comfortable, you know. She makes it alive and interesting, so it is easy for you to understand. I mean, she makes you feel as if you can ask anything, you know. She doesn't make you feel shy.

St1: If I want to ask a question, I sit there in the front so that the rest can't see me.

(Much laughter)

I: Is this different then from other subjects? I don't want you to name the other subjects. Do you find that some of the other subjects not presented in the same way?

St3: They don't realise there are L2 speakers. They like just speak as if they are speaking to L1 speakers.

I: So, you feel that in chemistry at least Miss P overcomes the problems that language might cause. I have taken some of the comments from the questionnaires and I thought that we could perhaps look at them - I don't know how you feel about that and tell me why you think some of the students might have made these comments.

The first comment is 'She treats us equally'. *(I hand out copies of comment to students).* Why do you think a student might have said this? I was very interested by this.

St3: I think it all comes back to what she said, *(pointing to student 4)* making us feel comfortable - she is not a dominating person, you can speak to her anytime even not in class, when she's in her office you can just go and see her and tell her your problems.

St4: Like she makes it relevant to all of us - L2 and L1 speakers.

I: I am also interested in knowing how you are doing in Chemistry. Are you coping with the course?

Sts: *(chorus)* Yes.

I: Quite well? Better than you expected to cope?

Sts: *(chorus)* Yes.

I: I thought 'She treats us equally' also had to do something with subject knowledge. Like, if you were better at chemistry or did a lot more Chemistry at school, it didn't advantage you necessarily she seemed to teach people equally, I don't know.

St3: Yes, she teaches as if it is the first time you are hearing it.

I: Then the second one we could have a look at is 'She makes learning fun'. (*hands out copies to students*). Would anybody like to comment on that?

St5: I think it has something to do with the drawings on the board and the way she illustrates something that she is teaching like taking a student from the lecture and asking what she knows about that subject or topic ....

I: You mean when she does the role play. Do you like that? Don't you hate being part of the role play?
(Much laughter)

St3: Being part is fine, but I like to watch others role play, that's very fine.

St4: And it is more easier to understand what is going on.

St2: Once you have role played, it is better.

I: So, you think it has got to do with the diagrams, the pictures, the role play ...

St3: Another thing is like she tells us stories about these chemistry people and her experiences, it becomes interesting and when you are writing a test or an exam you think of the things she told us in class and it actually is easy to remember.

I: So, even when you are writing tests you make those associations?

Sts: Yes.

I: When I thought about the comment 'She makes learning fun', when I was in the class she would use examples from everyday life. How do you feel about this?

St3: It is okay - you think of that when you are learning.

I: I thought we could look at a criticism. Look at this comment 'The lecturer must try to come down, she flies too high'. What do you think the student meant by that?

St4: Maybe she means she is too fast.

I: Could be that they didn't understand the content. Would you agree with this comment?

St1: I would disagree with this. Maybe the student did not get the right background from the things that Miss P taught us in the class.

St2: I don't agree.

I: I suppose by that comment that the student means she goes over my head, I don't understand what she is teaching or ....

St6: ... maybe it's because she doesn't follow the textbook ...

St3: She jumps around. But that makes it more interesting - because, like the way she teaches, she doesn't teach from page to page but she associates with that thing - she teaches you all about electrons, so you know everything - it is not that today she teaches acids and tomorrow is something else. She is actually um teaching us to study by ourselves. Because you know that, you know that you learnt about acids today and you can basically go to your textbook and read it because she does tell us what we've learnt and we've got our study guides ...

I: So, you feel that you would basically disagree with this comment. What about the next one 'I was taught to memorise at school'.

St3: That's true - you had to learn formulaes nê, and then just apply them; not to think or reason and she teaches us to think and reason.

St2: *(indistinct)* I think .... you need to understand.

I: Doesn't Miss P ask you to memorize?

St3: No! She is against that thing.

St2: But, there is things you have to memorise - but we analyse formulaes ...

St1: There are formulaes, okay that we need to be able to use (*indistinct*).

I: The other question I wanted to ask you was do you think that learning chemistry through the medium of English, now accepting that you are Xhosa speakers, has been a disadvantage - that you would have done better if you had been able to learn chemistry through the medium of Xhosa.

St4: Huh. Xhosa is very complicated and very difficult I mean, I don't think someone will be able to explain chemistry in Xhosa. I would find it difficult, It is better in English.

I: Do you think it is because you learnt chemistry in English at High School?

St4: Most probably.

St3: From std. 3 onwards we were taught Science through the medium of English - maybe if we had been taught through the medium of Xhosa from std. 3.

I: Here is another interesting point. This one says 'Everyone is free in the chemistry class because the lecturer is also free with us'. What do you think the student meant by 'free'?

St3: I think it goes back to the point of being comfortable in class. She also knows the difficulties people encounter.

St1: And also when you ask questions she is able to tell whether you don't understand the language or you don't understand the thing that she is teaching.

I: She can pick up whether it is the concept you haven't got or the language that is a problem.

St3: The way she explains it makes the concept very easy.

I: Think back on the semester because tomorrow is your last lecture, has there ever been a time when you felt lost on the course?

Sts: Not really.

I: Do you have peer supporters? Any of you here? Do you find that helpful?

St3: For some of us we don't like to ask questions in class or sometimes we don't want to approach the lecturer, then we can go to the peer supporter and they will explain - it could be the age group.

I: Okay, that's great. Is there anybody who would like to add anything else? Thank you. I really appreciate your giving up your lunch hour. Thanks once again.

.....

TRANSCRIPTION OF INTERVIEW WITH L1 SPEAKERS

INTRODUCTION [Same as L2 group]

.....

I would like you to think about whether there are differences or similarities between the way chemistry is presented compared with other subjects? If there are, can you give me some idea.
(*Silence*)

St1: I reckon you can't really compare chemistry lectures to other lectures because we only have two mass lectures, chemistry and Subject X, and Subject X lectures aren't given very well, I don't think.

St2: I agree. Ja, ja.

I: Can we focus on the two, chemistry vs Subject X just because they are both mass lectures.

St3: What I found in chemistry is that Miss P takes more care to make everyone understands.

St2: She can relate to us.

St3: Yes, she gets down to the basics, basically makes it understandable for everyone. In Subject X I find they basically just say something and they don't really get down to the basics of why it is like that and I find that especially people who aren't English speaking I don't know how they cope with that. I'm sure they find that a problem. But with Miss P I think basically anyone can understand.

St2: In Subject X they teach straight from the textbook so you may as well not go to the lecture, it's like having it read to you.

I: And no time for questions?

St4: Oh, they ask if everyone understands, but everyone is so taken aback ...

St3: If you say you don't understand ...

St5: Why ask? You have it read to you again.

I: So, they don't try alternative ways to make you understand? And in chemistry?

Sts: (*3 together*) Oh yes.

St2: She goes in from all angles, pictures ja.

St3: She listens to people's point of view as well. She doesn't straight away say no. She lets them say what they think and then - all the options - and then everyone must decide which one they think is the best.

I: You don't find, as L1 speakers, that this becomes tedious or boring?

Sts: *(chorus)* No.

St2: I actually enjoy her lectures.

I: One of the videos of the lectures that Miss P and I watched together she said that she was explaining a concept for the fifth time. You don't find that you lose interest?

St3: I find that it actually helps us because if you understand it the first time every time she goes over it, it becomes clearer and you don't have to go home and learn it. I mean you will learn it, but every time she explains it you understand it more.

I: I would like to ask you to think about chemistry at school. Is there a difference between the way chemistry is presented here and the way it was done at school?

St5: Yes, my teacher read out of a textbook.

St3: Then I had someone similar to Miss P, he had a doctorate, but what I found was that he made me interested in the subject and he concentrated on making people understand, he didn't really stick to the textbook - so he is basically similar to Miss P.

St1: I also had a similar teacher .... he sort of gave someone an interest in the subject, like me, I was hardly interested in the chemistry, more interested in Physics at school as the actual Physics part was made more alive but here it's the other way around, Physics is dead and chemistry is alive.

I: And what I'm interested in is how are you doing in chemistry?

Sts: *(chorus)* Much better.

I: Than at school?

Sts: Ja.

St2: If you enjoy your lecturing you do so much better - it's not on purpose that you do it, but it just comes out.

St1: Whenever I speak to people outside the technikon and say that I am not enjoying Subject X and my marks are going down they say well you can't blame the lecturer, but then how can I explain my marks going up in chemistry, it must have something to do with the lecturer, the lecturer sure makes a big difference. Okay, it is down to us to pass Subject X, but if your lecturer makes it so dead and so boring that you lost interest, you can't really .... it's it's exceptional students that ....

St3: Especially in your first year when you are still trying to find your way.

St1: and even more so when you are not English speaking.

I: When you write your weekly and semester tests, do you retain the associations that Miss P makes in class?

Sts: Yes.

St3: Sometimes, not all the times, but especially if I am studying from the textbook, the language they use is complicated and especially if I compare my notes I find I can relate, I mean the textbook sometimes has a bit more than we did in class, but the two like interact, pretty well.

I: I notices that Miss P often doesn't even refer to the textbook.

St3: I don't know about the others that's what I like about it, you don't follow in a set way. You go and you don't know what to expect from her, I mean, one minute, not that she jumps around, but it's not the same old boring lecture and you go through the textbook.

I: I like you to think about the following comment which I took from one of the questionnaires. 'She treats us equally'.

St2: Sometimes lecturers look down on you, I find. I know some lecturers especially when you ask a question make you feel so stupid, and says you're not going to pass, but I'll go over it.

St5: Miss P always make you feel you have made a valid point. And at school teachers had a lot of favourites and that, we don't have with Miss P.

St3: You find with Miss P that she has made a point to learn names, all the Xhosa students names, and if she like asks a question, she doesn't pick on the same people, she tries to spread it around, I mean with us being English we have easier names. I mean, I find especially at the end now she basically knows the whole class. She asks everyone, you know, what do you think? Even if the person gets like all embarrassed, she will listen to what they have to say and speak from there. She doesn't just pick on the same people.

St2: It's actually surprising as she knows our first names and surnames, I don't know how. Like one day in a lecture she said, Yes, Miss .....
(*Much laughter from students*)

I: I was wondering, being L1 speakers, if you felt you were not given attention, because you probably know it all ...

Sts: No, not at all.

I: Another comment that I thought was quite interesting, let's have a squiz at this is 'Makes learning fun'.

St1: She awakens our interest in the subject.

St2: She really livens it up. She draws pictures, tells stories.

St3: Ja, she tells stories, but then there are real stories as well, not made up, I'm sure she tells real stories.

St1: I'm sure she tells real stories.
(Students laugh).

St1: ... it seems that you can somehow benefit from it, it's not like at school when you learn a subject you know you are learning the stuff, but you are never going to use it, you are learning it to get a mark, but this stuff you know you are going to use sometime, somewhere, it makes it real.

I: So your interest is activated ...

St3: I mean, the whole thing is basically that chemistry can be an extremely boring subject because it's just supposed to be straightforward learning. She makes it more understanding than learning. She tells us to read the textbook like a book, don't sit and study it, read it like a book and make sure you understand what she has spoken about, that's the main thing. I don't know about fun, I don't know if I am taking it out of context, the fun part, it's just that, I mean she makes it a lot easier and exciting. I mean Subject X is supposed to be an interesting subject, but I find it extremely boring.

St6: Yes, very boring.

St3: If they could approach it in another way, they could make it a lot more interesting and students would do better. With Subject X I feel they can change the teaching aids at least, I mean bring in a few things, a basic experiment type of thing where people can see what is happening not just listening the whole time, but observing as well.

St2: They don't explain the technical terms, they just go ahead. They use omega, but don't explain, but I don't know what omega is in this formula, there's all these funny symbols and you get a bit lost.

I: And in chemistry ...?

St3: If we had to come across something like an omega she tries to give us a way of remembering what it is.

I: And the role play, how do you feel about that?

St3: She does different things all the time, you don't know what to expect.

Sts: It is embarrassing, but it's fun.

St3: When you get back you think that was fun.

I: I want us to look at another comment which I think we have already touched on, but let's think about it anyway. The comment is 'She will not make you feel stupid.'

St3: In the beginning everyone was like nervous.

St6: Shy, because of the big class.

St3: But now, if you look back now at the end of the semester the amount of people who are asking questions, okay, there are still people who don't ask questions, but I'm sure 70% of the class are asking questions, but in the beginning one or two people would ask questions. There's a lot more confidence.

I: And if you are not confident enough, can you get to see the lecturer?

St5: Yes, she always says pop into my office afterwards.

St2: She has actually even said if I'm not there leave a note, she has a note pad on the door, she'll contact you if you leave a phone number.

I: Now, how many of you have been to see her.

St2: I've been.

I: And the rest?

Sts: No, we haven't been.

St3: But a lot of people have made use of it.

St2: I think so, you know even if your one test was bad, she shows you how you are progressing, she doesn't like say, like I went once to my Subject X lecturer and said what could I do, because I had like failed a test, so he said well, like learn basically, obviously.... but he didn't notice that I had come up like 10%, it was like so, like she would have noticed, she would have said you have increased, next time it will be 10% more.

St7: She always builds up your confidence, she doesn't break you down.

St4: She says don't give up hope. I struggled as well.

St7: She isn't like a lecturer, she is more on a personal level, she isn't like, she's there and I'm here.

I: I wonder if it has something to do that she studies overseas - this might make you more aware of other cultures and needs.

St3: I have a feeling that that has a little to do with it ...

I: The comment we have also touched on 'By using things we can relate to'.

St4: indistinct

St7: She keeps reminding us that there is a point to us studying that we will use it one day in our job.

St3: Not just a waste of time, just doing it ...

I: Does she use examples from everyday? Does she demystify chemistry I mean, chemistry to me was a separate world with a separate language, once or twice when I was in the class she spoke about everyday things and I thought maybe that was what the student meant as well.

St3: It probably is. She often relates things to her past experiences, because I mean she has studied a lot, she's had certain experiences here and there which she will relate and she will be talking about it and she will say this is what happened.

I: And then this is a criticism from the questionnaire 'The lecturer must try to come down, she flies too high'. How do you interpret that?

St1: Maybe this student feels left behind and hasn't grasped the concept.

St3: Basically, I thought it was the opposite, if I were a L2 student, I would have appreciated her classes a lot more than any of the others.

St6: Ja, ja.

I: Do any of you in this group have peer supporters?

Sts: No.

I: Right, and then the second comment. 'I was taught to memorise at school'?

St2: That is just what she is trying to make us not do.

Sts: That's right.

St4: She says come to me, I'll show you how to learn.

St3: This is in contrast to at school. Maybe that's why they find it difficult now because at school they were told this is what happens, you don't have to think, just do it.

St2: My Maths at school we were told to memorise - don't worry about this, they were just channelling to get us through matric, it is all exam orientated, just to better the school's matric marks. As long as you can remember and memorise.

St6: You must just accept, we are not taught to think.

St2: And you don't feel insecure with this at all.

St3: Some people might because it is a little more than just straight learning. You might want to ask a question that is not exactly in the book, but you don't.

I: Okay, anybody who would like to ask a question or add a comment? I want to thank you once again for giving up your time, in fact your lunch time, I really appreciate it.

COMMENTS

Working with Mrs Potgieter on this project has been a very enriching and inspiring experience.

I do not think that Mrs. Potgieter's (and the videocamera's) presence in my lectures influenced me to a very large extent. The reason for this is that I have often presented "this is how I teach ...." workshops at different regional and national conferences. The people that attended these workshops are our countries' best science teachers and science teaching researchers - and I survived them quite well! I am also very keen on improving my lecturing techniques on an ongoing base. The best way to do this is to try to be as normal and natural as possible in front of the evaluator/camera etc. I often forgot that they were there.

My reason for using that specific introduction to the course was to make the students more aware of the project, to put them at ease and to introduce Mrs Potgieter as a "natural" part of the course. It will be difficult to find out whether I achieved my goal!

Mention must be made that many techniques I use, are the "fruits" of my many contacts and discussions with educators (science and other). The didactic courses I did as a part of my HDE also played a very significant role. Some techniques I have to consciously work at, others have become second nature. The biggest challenge for me is to be able to see inside the students' heads. Only when one knows what they think, can one start to think of ways to explain and clarify work to them. This ability comes with experience, especially with one to one contacts with students.

I especially appreciate the analysis of my lectures by Mrs Potgieter in chapters four and five. I did not expect such an overwhelmingly positive reaction from my students. My usage of the English language I find shockingly poor. I do not think that the students' English improved because of this course! Maybe one could get similar results using a bit better English, e.g. to complete my sentences at least!

Looking at the video's with Mrs Potgieter, analysing them and discussing them has given me much to think about. I can definitely recommend this to anybody wanting to improve their lecturing. Having read the theory part of this thesis made everything make more sense to me. I am happy that I only read it afterwards.

I feel honoured to have been a part of this project. My sincerest thanks to Mrs Potgieter for her very professional attitude, kindness and inspiration. I do hope that this will benefit lecturers and students in the future as much as it benefited us!

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