THE DISCOURSES OF SECONDARY SCHOOL MATHEMATICS

Volume 2

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CHAPTER 6

Learning Mathematics and Femininity

Teacher OK what letter would we like best today? 'p'... 'p' squared.
Put a three there. Umm, plus four 'p'.
Why is it safe for me to put minus on the end?

Extract from Lesson B

The format for the analysis of Lesson B is similar to the one for Lesson A in Chapter 5. However, at times features of Lesson B call for a different emphasis. In addition, the nature of semiotic metaphor resulting from shifts between language and mathematical symbolism is further explored in this chapter in combination with lexicogrammatical strategies for packing experiential meaning. These strategies are nominalisation in language and clausal rankshift in mathematical symbolism.

6.1 Contextualisation of School B

The performance of students from School B in the 1995 TEE for Applicable Mathematics, Calculus and Discrete Mathematics is displayed in Figures 6.1, 6.2 and 6.3.

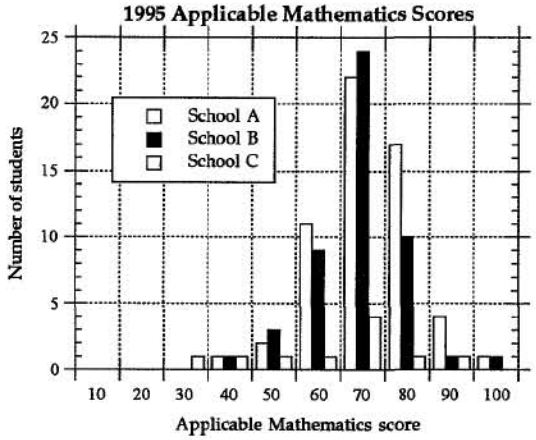


Figure 6.1 Applicable Mathematics

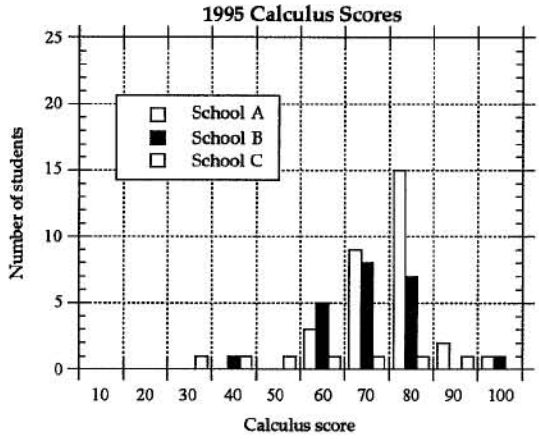


Figure 6.2 Calculus

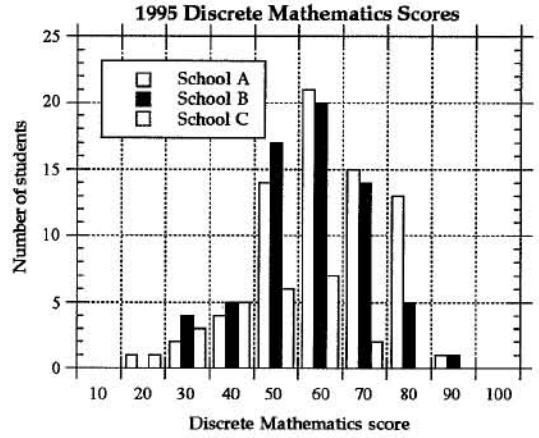


Figure 6.3 Discrete Mathematics

As may be seen, the gross number of students who complete TEE mathematics in School B is less than School A but far in excess of School C. Further to this, although the average scores for students from School B in each mathematics subject are less than the mean scores for School A, they nevertheless are slightly higher than the state averages as displayed in Table 5.1 in Chapter 5. This means that while success in the discourse of secondary school TEE mathematics in School B is not as marked as School A, it is nevertheless better than average. The students in School B certainly outperform their counterparts in School C.

6.2 Lesson B

The full transcript and the stages of the board text for Lesson B appears in Table 3(i).1 in Appendix 3(i). Lesson B is an algebra lesson which commences with a student outburst that the homework was difficult.

24	Helen	// Mr X that homework [[you gave us]] was so hard
25	Helen	// I got this male teacher in
26	Helen	// and we spent four and a half hours
27	Helen	// and I 'm still not getting it all right
28	Ss	// <laughter>

As a consequence the teacher reviews the homework which involves the solution of quadratic equations using the quadratic formula. After the teacher works through a problem, the students complete an example on their own. The teacher demonstrates how the solution may be found using a calculator and then the students are directed to work through two more examples. After these are checked, the students attempt a word problem which involves the solution of a quadratic equation. Given student difficulties with the problem, the teacher demonstrates the solution on the board. Following this, the students complete two more examples on their own. Given further difficulties, the teacher works through the first example on the board. The lesson finishes with the teacher directing the students to review the work at home as there is to be a mini-test in the next lesson. The teacher offers lunchtime help for any students who are having problems.

6.21 The Curriculum Macrogenre and the Lesson Genre

As the teacher reviews both the homework and the word problems, Lesson B constitutes a mixture of the Curriculum Development and Curriculum Application stages. The lesson genre is the optional Review Lesson which occurs in each of these stages. In Lesson B, the homework constitutes the 'Theory' and the word problems constitute the 'Applications'. It is quite possible that the teacher had intended only reviewing the word problems but changed direction after the student complaint. After mentioning that some word problems were completed "the other day", the teacher states "now the only other thing we have to do girls is the word problem situation and then we have finished this book" (clauses 778 and 779). This odd mixture of the Lesson Genres helps to explain the disjointed structure of the lesson which is apparent in the examination of the microgenres.

Table 6.1 The stages of the curriculum macrogenre and the constituent lesson genres

STAGES	LESSON GENRE
Curriculum Initiation	Review Lesson
Curriculum Development	Theory Lesson Theory/Practice Lesson Practice Lesson Practical Lesson **(Review Lesson)**
Curriculum Application	Theory Applications Lesson Theory/Practice Applications Lesson Practice Applications Lesson Practical Applications Lesson **(Review Lesson)**
Curriculum Review	Unit Review Lesson
Curriculum Evaluation	Test/Examination Test/Examination Followup

The mathematics unit being taught in Lesson B is Mathematics Development Unit 5.4 and the objective is "Objective F5.8" located within the Function strand.

> Objective F5.8 Solve algebraically problems involving quadratic equations
> (Curriculum Directorate, 1990a, p. 69).

6.22 The Microgenres

The unfolding of the microgenres of Lesson B is given in Figure 6.4. These are listed below in order of appearance according to the number assigned in section 2.223.

2. **Settling into Work (SIW)**
   PRE-LESSON GENRE:
3. **Student Conversation(SC)**
   PRE-LESSON GENRE
1. **Teacher Preparation (TP)**
   PRE-LESSON GENRE
4. **Teacher Conversation (TC)**
   PRE-LESSON GENRE

17. **Classroom Business (CB)**
PRELIMINARY GENRE
8. **Teacher Disciplinary Interruption (TDI)**
INTERPOLATED DISCIPLINARY GENRE
21. **Teacher Motivation (TM)**
PRELIMINARY GENRE
9. **Student Interruption (SI)**
INTERPOLATED DISCIPLINARY GENRE
16. **Attendance (A)**
PRELIMINARY GENRE
23. **Diagnostic Activity (DA)**
PRELIMINARY GENRE
30. **Homework Discussion (HD)**
PRELIMINARY GENRE
28. **Copying Notes (CN)**
PRELIMINARY GENRE
33. **Teacher Exposition (TE)**
PRELIMINARY GENRE
24. **Student Review Task (SRT)**
PRELIMINARY GENRE
13. **Teacher-Student Private-Public Interaction (TSPPI)**
INTERPOLATED GENRE
14. **Teacher-Student Private Interaction (TSPI)**
INTERPOLATED GENRE
25. **Student Review Task Discussion (SRTD)**
PRELIMINARY GENRE
15. **Student-Student Private Interaction (SSPI)**
INTERPOLATED GENRE
35. **Seat Work (SW)**
MAIN LESSON GENRE
34. **Board Demonstration (BD)**
MAIN LESSON GENRE
36. **Seat Work Discussion (SWD)**
MAIN LESSON GENRE
46 **Closure (C)**
END OF LESSON GENRE

Lesson B lacks the clear structure of Lesson A, with its erratic movements between multiple microgenres as displayed graphically in Figure 6.4. Given that it is a hybrid of two lesson genres in part directed by student comments, Lesson B lacks an obvious preconceived structure. Instead, the movements seem to be influenced by immediate contextual parameters in a way that is not found in Lesson A. As a result, the microgenres of Lesson B unfold in a rather unpredictable manner.

Initially the teacher experiences difficulty in creating a focus of attention. This is evidenced by the Teacher Disciplinary Interruption, the Student Interruptions and the first failed attempt at the Homework Discussion. The

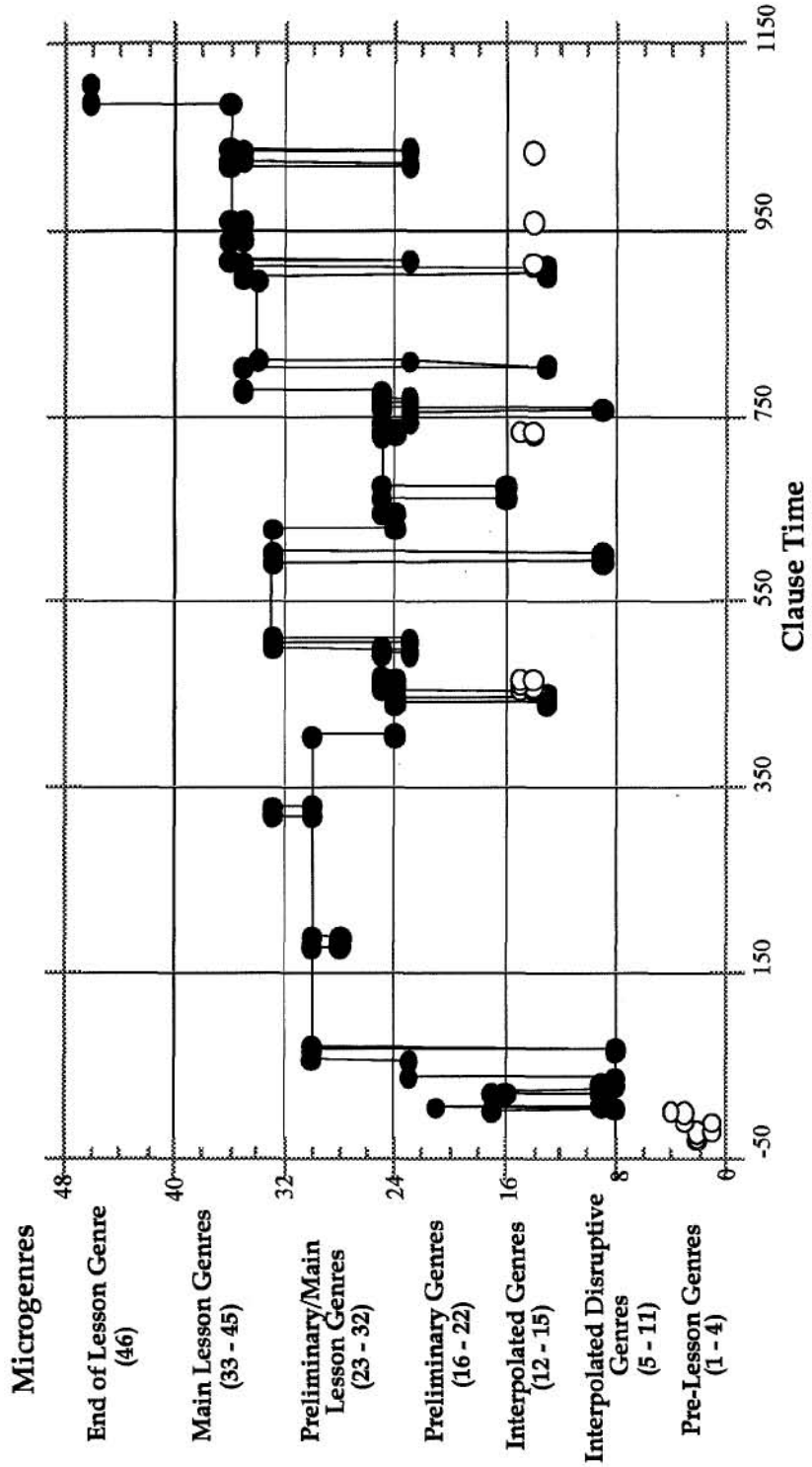


Figure 6.4 Lesson B - The sequence of microgenres

From \ To	SC	TC	TDI	SI	TSPPI	A	CB	M	DA	SRT	SRTD	CN	HD	TE	BD	SW	SWD	C
SC		1																
TC							1											
TDI								1	1			1	1					
SI			1				1				1			1				
TSPPI									1	1	1					1		
A				1							1							
CB			1			1												
M				1														
DA				1							2		1	1	1		3	
SRT					2						4							
SRTD						1			3	3				1		1		
CN													1					
HD			1							1		1		1				
TE				1					1	1			1					
BD																1		
SW					2				2									
SWD									1							2	1	1
C																		
Total		1	3	4	4	2	2	1	9	6	9	2	4	4	1	5	4	1

Figure 6.5 Lesson B - The microgenre transition matrix

teacher also introduces me to the class in what I have classified as a Classroom Business microgenre. Although the interactions constituting this microgenre are not included in the transcript, the lesson nevertheless does not really commence until clause 71. Once under way, apart from the Copying Notes microgenre, the Homework Discussion unfolds without interruption until the Teacher Exposition where even the teacher comments "so I got sidetracked" (clause 330). Once the Student Review Task commences, there are multiple occurrences of private interactions and Teacher-Student Private-Public Interactions. After the Student Review Task Discussion and two incidences of Diagnostic Activity, the discussion of finding the solution using a calculator realises the Teacher Exposition microgenre. A Student Interruption (clause 594 to 603) sidetracks the discussion somewhat. The Student Review Task and Student Review Task Discussion occur for a second time punctuated with what is usually a Preliminary microgenre, Attendance and other microgenres such as Student Interruptions, Diagnostic Activities and private interactions. The teacher attempts to review the word problems through the microgenre Seatwork (clause 778), but when the students experience difficulty, the microgenre Board Demonstration is realised. Seatwork then resumes once again punctuated with Diagnostic Activities, private interactions and Seatwork Discussion with the final microgenre being Closure.

The microgenre transition matrix given in Figure 6.5 shows that there are multiple transitions into the same microgeneric states from a previous state. In total there are nine transitions into Student Review Task Discussion and Diagnostic Activity microgenres. There are six transitions into Student Review Task, five into Seatwork and four into Student Interruptions, Teacher Student Public Private Interactions, Homework Discussion, Teacher Exposition and Seatwork Discussion. In addition, there are three movements into Teacher Disciplinary Interruption. This contrasts dramatically with Lesson A where transitions from one particular microgeneric state to another occur only once and there are lower totals of transitions into particular states. Significantly those microgenres displaying surges of interpersonal meaning such as Student Interruption and Teacher Disciplinary Interruption occur more often in Lesson B.

The range of the Field, Tenor and Mode selections for the microgenres of Lesson B is greater than Lesson A as shown in Figure 6.6 below. Although

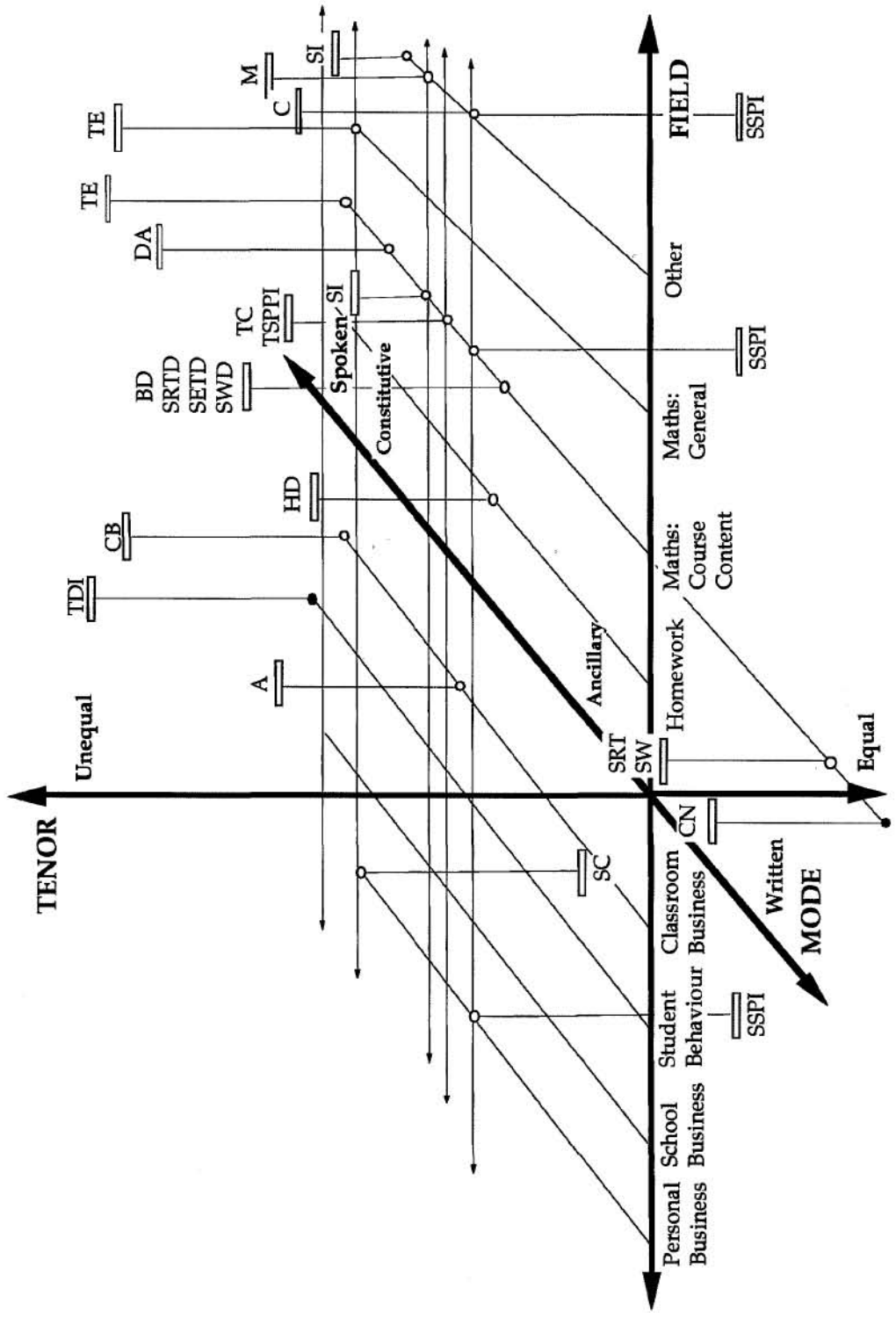


Figure 6.6 Lesson B - Dimensions of the microgenres

unequal tenor relations predominate between the teacher and the students, student private interactions realising equal tenor relations occur often. As microgenres such as Teacher Exposition and Student Interruptions occur more than once, the Field selections show variation within a range of options. On occasions, the interactions steer away from the course content into other areas. In combination with the greater number of microgenres of Lesson B, the Field deviates from the course content more often than that of Lesson A. The Mode selections shift according to the stage of the lesson and the constituent semiotic code through which meanings are made.

6.23 Interpersonal Meaning

The interpersonal meaning of the oral discourse of Lesson B is followed by discussion of the symbolic board text. In examining interpersonal meaning, it is my contention that the diverse patterns of deference realised in Lesson B do not accord with the position of dominance realised in the discourse of mathematics. Further to this, lexicogrammatical choices function to foreground interpersonal meaning. This results in a deflection of emphasis away from experiential and logical meaning.

6.231 General Lexicogrammatical Patterns, NEGOTIATION and Interpersonal Metaphor

As displayed in Table 3(i).1 in Appendix 3(i), the oral discourse includes private interactions which are marked with a projection of "**". Unless specifically stated, the analysis does not include these clauses due to constraints of the study.

A summary of the nature of the exchange structures is given in Table 6.2 below. The length of the exchanges of Lesson B is the shortest found in any of the four lessons considered in this study. This indicates a limited proliferation of clause complex relations and Dynamic Moves. As for each lesson, the number of student initiated exchanges is minimal with the maximum found in Lesson C1 and the minimum in Lesson A. The low ratio of student clauses to teacher clauses is a significant feature of Lesson B. Proportionally, the student contribution in Lesson B is the lowest found in any of the lessons.

Table 6.2 Exchange structure

NATURE OF EXCHANGES	
Number of Exchanges	404
Average Length of Exchange	2.64 clauses
Teacher Initiated Exchanges	398
Student Initiated Exchanges	6
Ratio of teacher clauses: student clauses	1: 0.13

The dominating position of the teacher is evident from his speech role of primary knower and secondary actor as displayed in Table 6.3 below. This trend is most definite across all lessons. What is to become apparent, however, is that, unlike Lesson A, differing patterns of deference are manifested in Lessons B, C1 and C2.

As seen in Table 6.3, the students answer in chorus on fifteen occasions. This indicates that personal responsibility for what were often extended student answers in Lesson A does not always occur in Lesson B.

Table 6.3 Speech roles of the teacher and students

Ranking Clauses: SPEECH ROLES (n = 1067)	Teacher		Student	
	Total	Percentage (1 d.p.)	Total	Percentage (1 d.p.)
Knowledge	699	65.5	116	10.9
Primary Knower (dK1, K1, K1f)	660	61.9	18	1.7
Secondary Knower (K2, K2f)	39	3.7	83	7.8
Secondary Knower (Kn)			15	1.4
Action	244	22.9	8	0.7
Primary Actor (dA1, A1, A1f)	2	0.2	7	0.7
Secondary Actor (A2, A2f)	242	22.7	1	0.1

In Lesson B, the majority of clauses are concerned with knowledge as displayed in Table 6.4 below. This trend is found in all the lessons, and although comparable to Lesson C2, the greatest proportion of action moves are realised in Lesson B. Although the students contributions are low, along with Lesson C1 the students adopt the speech role of primary knower more often than in Lesson A, albeit in only 1.7% of cases. As I later discuss, however, this does not necessary ultimately lead to a position of power in the widest sense of the word.

In Lesson B, the proportion of Dynamic Moves associated with both knowledge and action is small with student contributions being proportionally the lowest across all lessons. There are instances of Reacting which realise surges of interpersonal meaning not found in Lesson A.

Table 6.4 Selections of SPEECH FUNCTION

Ranking Clauses: SPEECH FUNCTION	The Lesson		Teacher Contribution		Student Contribution	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
	1067	**100**	**943**	**88.4**	**124**	**11.6**
Knowledge	**815**	**76.4**	**699**	**65.5**	**116**	**10.9**
Calls	37	3.5	37	3.5	0	0
Propositions	594	55.7	499	46.8	95	8.9
Dynamic Moves	160	15.0	141	13.2	19	1.8
Follow-up	20	1.9	19	1.8	1	0.1
Reacting	4	0.4	3	0.3	1	0.1
Action	**252**	**23.6**	**244**	**22.9**	**8**	**0.7**
Proposals	219	20.5	215	20.1	4	0.4
Dynamic Moves	29	2.7	25	2.3	4	0.4
Follow-up	4	0.4	4	0.4	0	0
Reacting	0	0.0	0	0	1	0.1

The SPEECH FUNCTION and MOOD selections for each ranking clause in Lesson B is given in Table 6.5 and displayed according to speech role and speaker in Tables 3(ii).1 to 3(ii).8 in Appendix 3(ii).

Table 6.5 SPEECH FUNCTION and MOOD: Teacher and student contributions

	KNOWLEDGE						ACTION				
TOTAL	Call	Prop-ositn	Dyn-Move	Foll-Up	Rea-cting	Total	Prop-osal	Dyn-Move	Foll-Up	Rea-cting	Total
Decl-arative 719 67.4%	9	446	118	9	3	585 54.8%	106	24	4		134 12.6%
Teacher	9	354	103	8	3		103	20	4		
Student		91	15	1			3	4			

YN-interrog 63 5.9%		28	12			40 3.7%	23				23 2.2%
Teacher		28	11				22				
Student			1				1				
WH-interrog 114 10.7%	9	87	17			113 10.6%	1				1 0.1%
Teacher	9	87	17				1				
Student											
Imper-ative 102 9.6%		5	3	1		9 0.8%	89	4			93 8.7%
Teacher		0	3	1			89	4			
Student		5									
Exclam-ative 2 0.2%			2			2 0.2%					0 0.0%
Teacher											
Student			2								
Paralin-guistic 5 0.5%		3	1		1	5 0.5%					0 0.0%
Teacher					1						
Student		3	1								
Minor Clause 62 5.8%	19	25	7	10		61 5.7%		1			1 0.1%
Teacher	19	25	7	10				1			
Student											
1067 100%	37	594	160	20	4	815 76.4%	219	29	4		252 23.6%

Several features of interpersonal meaning of the oral discourse of Lesson B become evident from the analysis of SPEECH FUNCTION and MOOD. Firstly, exclamatives and paralinguistic behaviour are realised in Lesson B. These surges of interpersonal meaning are not found in Lesson A. Secondly, patterns of deference are realised in Lesson B through interpersonal metaphor as opposed to interpersonal congruence. This is best illustrated through the examples of MOOD TAG selections, the MOOD selections for commands realised by the teacher and the nature of student responses to questions.

Table 6.6 Mood Tags

Clause N^{o}/ Speaker	MOOD TAGS
3 T	/ / alright girls can I just have your attention **please**
37 T	/ / can you open up the work **please**
57 T	/ / OK will you just look at the screen **please**
107 T	/ / you were away the whole time **were you**
115 T	/ / they will be exactly the same **won't they**
119 T	/ / could somebody read the quadratic formula [off their ah/ maths aids [for me]] **please**
123 T	/ / that looks complicated **doesn't it**
172 T	/ / you wouldn't be adding or taking anything then **would you**
195 T	/ / it 's a funny name **isn't it**
275 T	/ / that 's good **isn't it**
282 T	/ / it will show error **won't it**
328 T	/ / it should say error **shouldn't it**
350 T	/ / no it 's minus three actually **isn't it**
366 T	/ / very convenient **isn't it**
440 T	/ / what the solutions are **please**
478 T	/ / minus four plus or minus the square root [of twenty eight] **wasn't it**
491 T	/ / Lisa what did you get **please**
553 T	/ / 'a' was three **wasn't it**
757 S?	/ / can you put it up a bit **please** Mr X
823 T	/ / that 's a mouthful **isn't it**
864 T	/ / cause that 's the next one along **isn't it**
898 T	/ / so can you do that **please** girls
972 T	/ / umm 'a' we used **wasn't it**
974 T	/ / everybody got twelve or minus fourteen **didn't you**
993 T	/ / that 'a' had to be positive **didn't it**
1059 T	/ / can be either **can't it**
1092 T	/ / [[what I 'd like [[you to do tonight]]]] is [[to finish that one and [[do number five]]]] **please**

A significantly greater incidence and variety of Mood Tags are realised in Lesson B compared to Lesson A. The twenty seven Mood tag selections are listed in Table 6.6. There are nine cases of "please" realising politeness and

deference. In addition, there are six examples of metaphorical realisations of commands in the form of polar interrogatives which are tagged with "please" (clauses 3, 37, 57, 119, 757 and 898). These examples of interpersonal metaphor occurring in tandem with tagging realise double-edged patterns of deference. In addition, the Subject of the Mood Tag is more often the mathematical content in Lesson B. This indicates that agreement with the mathematics statements requires coercion rather than presumption as found in Lesson A.

The MOOD selections for teacher commands are displayed in Table 3(ii).6 in Appendix 3(ii). Of the one hundred Initiating moves, there are twenty eight declaratives, fourteen polar interrogatives and fifty eight imperatives. This means that in approximately 42% of Initiating moves, the MOOD selections realise interpersonal metaphor as opposed to interpersonal congruence. For the Continuation moves, over thirty percent are declarative or polar interrogatives while the A-x moves are predominantly declarative.

Table 6.7 Imperative commands with MOOD structure

Clause N^{o}/ Speaker	Subject	Finite	Residue
58 T		don't	worry [about your work] too much
61 T	let's	have	just have a look at this together
109 T	let's	say	say
313 T	let's		just read that again
337 T	let's		do this [in our head]
372 T	you		go [[[[minus one plus or minus the square root of twenty five]] over [[two twos are four]]]]
472 T	let's		just see
561 T	you		push
567 T	you		go
616 T		don't	worry
787 T	let's		perhaps look at question two <two 'a'>
816 T	let's		do it together
857 T	let's		just start [with 'a']
886 T	you		just go [[equals three forty]]
919 T	let's		make sure
1038 T	those [[that are having trouble]]		have a look

Those imperatives containing MOOD selections are listed in Table 6.7. These are proportionally fewer than found in Lesson A. The selection for "you" occur proportionally more often than and the strategy of selecting

"let's" is not as prominent. In the latter case, "let's" may be a technique of dominance as its function is to create group cohesion.

As displayed in Table 3(ii).4 in Appendix 3(ii), on four occasions the student responses to teacher questions are disclaimers. However, students most often respond to questions with a declarative and there is only one instance of imperative. This differs from patterns in Lesson A where students are more likely to answer with an imperative.

Students are significantly less likely to realise Dynamic moves in Lesson B than in Lesson A. Although the students initiate Dynamic move on eight occasions, there is only one Request. Of the initiating moves, three involve challenges. These challenges are not directed towards the mathematics content as in Lesson A, but are rather directed towards deliberately shifting the field of the discourse or making excuses for not completing the assigned task. These include "we won" (clause 10) and "and Susan did too row" (clause 19) and "but I just don't understand it" (clause 807). The other nine Dynamic moves are Responses to moves initiated by the teacher.

Table 6.8 Moves, stages of exchange structure, SPEECH FUNCTION, MOOD selections

Clause N° / Speaker	Ex-change	Clause	MOVE, SPEECH ROLE, STRUCTURE, SPEECH FUNCTION, MOOD
128 T	44	// who can tell me	Call, K1, K-Initiation, summons, WH-interrogative
129 T	44	// what the 'a' is	Call, K1, K-x, summons, declarative
130 T	45	// hands up	Proposal, A2, A-Initiation, command, imperative
131 T	45	// if you can tell me the 'a'	Proposal, A2, A-x, command, declarative
132 Kar	46	// Karen	Call, K1, K-Response, bid, none
133 Kar	46	/// ah/ the two [in front of the [['c' squared]]]	Proposition, K2, K-Response, answer, declarative
134 T	47	// OK what 's 'b'	Proposition, dK1, K-Initiation, question, WH-interrogative
135 Kar	47	/// ah/ the plus one	Proposition, K2, K-Response, answer, declarative
136 Kar	47	// which is there	Proposition, K2, K-x, answer, declarative
137 T	47	// yeah	Dynamic, K1, K-Initiation, backchannel, none
138 Kar	47	// and the negative three is the 'c'	Proposition, K2, K-Continuation, answer, declarative

Despite the waves of interpersonal meaning, the nature of the dialogue may be described as consisting of short exchanges with little probing, clarification and explanation of the mathematical content. It is rather a ball being hit perfunctorily back and forth as opposed to a varied and intricate play resulting from considered responses. An example of such an interaction in Lesson B is given in Table 6.8 above.

Apart from interpersonal metaphor, the brevity of the exchanges, the chorus answers and paralinguistic behaviour, patterns of deference are realised in Lesson B through ellipsis. As seen in Table 6.9, 15.7% of all clauses are ellipsed.

Table 6.9 Clausal analysis

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	1063	100
MAJOR CLAUSES	998	93.9
Complete	798	75.1
Ellipsed	167	15.7
Abandoned	33	3.1
MINOR CLAUSES	65	6.1
NON-CLASSIFIED/UNKNOWN CLAUSES	14	

Table 6.10 Clausal analysis: Teacher and student contributions

	Teacher		Student	
	Total	% (1 d.p.)	Total	% (1 d.p.)
CLASSIFIED CLAUSES (Total 1063)	941	88.5	122	11.5
RELATIVE PERCENTAGES	941	100	122	100
MAJOR CLAUSES	880	93.5	118	96.7
Complete	742	78.9	56	45.9
Ellipsed	107	11.4	60	49.2
Abandoned	31	3.3	2	1.6
MINOR CLAUSES	61	6.5	4	3.3
NON-CLASSIFIED/UNKNOWN CLAUSES	3		11	

If the student contributions are considered separately as displayed in Table 6.10 , it may be seen that nearly fifty percent of clauses involve ellipsis. This is a significantly higher proportion than found in Lesson A where only 22.9% of the student clauses were ellipsed. It is interesting to note that in the private interactions between students and the teacher the proportion of ellipsis was slightly higher than found in the classroom interactions as displayed in Table 6.11. This indicates perhaps a lower level of formality in the private interactions.

Table 6.11 Clausal analysis: Private interactions

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	11	100
MAJOR CLAUSES Complete Ellipsed Abandoned	11 9 2 0	100 81.8 18.2 0.0
MINOR CLAUSES	0	0
NON-CLASSIFIED/UNKNOWN CLAUSES	18	

As displayed in Table 6.12, the modality and modulation are concerned predominantly with probability and obligation, and potentiality and inclination respectively. The relative proportion of potentiality is higher than that found in Lesson A. This is possibly a reflection of the higher incidence of interpersonal metaphor in Lesson B as realised by polar interrogative commands.

Table 6.12 Modality and modulation

(n = 934)	Totals	Percentage
MODALITY	781	83.6
Probability	780	
Usuality	1	
MODULATION	153	16.4
Obligation	106	
Inclination	20	
Potentiality	27	

The orientation and values for modality realising probability are displayed in Table 6.13 below. As for each of the other lessons, the modality values are high, with 75.8% in Lesson B realising maximal certainty with no metaphorical realisation of modality. Significantly maximal subjective explicit values realised by "I think" are most common in Lesson B. Although this is a maximal value, paradoxically nevertheless a degree of uncertainty is created. It is a 'personal opinion' only with no claim to universal truth. Equally the low objective values create uncertainty. Interestingly enough, the latter orientation is not found in Lesson A. However, the proportion of subjective implicit low values of modality in Lesson B is less than Lesson A. One contributing factor is that "can" tends to realise modulation in the form of potentiality rather than low values of probability in Lesson B.

Table 6.13 Probability: Modality

ORIENTATION / VALUE (n = 780)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal	591 (75.8%)	5 (0.6%)		52 (6.7%)
High	32 (4.1%)			
Medium	5 (0.6%)		51 (6.5%)	7 (0.9%)
Low	8 (1.0%)	1 (0.1%)	30 (3.8%)	

The relative percentage of explicit modality realising values of probability per ranking clauses is 4.1%, 6.1%, 3.7% and 3.2% for Lessons A, B, C1 and C2 respectively. This means that interpersonal metaphor in the form of explicit modality is greatest in Lesson B and lowest in Lesson C1 and C2. Ultimately this means that greater uncertainty is realised in Lesson B than any other lesson. The clauses realising plays of modality associated with probability for Lesson B are given in Table 6.14.

Table 6.14 Probability: Explicit realisation of modality

Clause Nº / Speaker	Clause	Value and orientation
34 T	// guys now **I know**	maximum, absolute, subjective
50 T	// well **maybe that 's** [[because we rushed it last week]]	low, possible, objective
86 T	// how many answers **do you think**	maximum, absolute, subjective
90 T	// **is it possible**	maximum, absolute, objective
94 T	// Steph what **do you reckon**	maximum, absolute, subjective
176 T	// **in fact** that 's got a special name	maximum, absolute, objective
179 T	// **I 'd like**	median, probable, subjective
196 T	// what **do you think**	maximum, absolute, subjective
199 T	// which word **do you think**	maximum, absolute, subjective
202 T	// what **do you think** Fran	maximum, absolute, subjective
205 T	// what **do you think**	maximum, absolute, subjective
209 T	// what **do you think**	maximum, absolute, subjective
226 T	// Louise what **do you think**	maximum, absolute, subjective
246 T	// **I wonder**	maximum, absolute, subjective
250 T	// what **do you think**	maximum, absolute, subjective
258 T	// **I want** an answer [for this] guys	maximum, absolute, subjective
261 T	// what **do you guys think**	maximum, absolute, subjective
264 T	// **and in fact** she 's right	maximum, absolute, objective
299 T	// and Sarah what **do you think**	maximum, absolute, subjective
338 T	// what **do you think**	maximum, absolute, subjective
391 T	// whichever **you like**	maximum, absolute, subjective
394 T	// **I suggest**	maximum, absolute, subjective
407 T	// **I think**	maximum, absolute, subjective
411 T	// OK what letter **would we like** best today	median, probable, subjective
434 T	// if **I want**	maximum, absolute, subjective
470 T	// alright **you probably don't want**	median, absolute, subjective
474 T	// **I assume**	maximum, absolute, subjective
502 T	/// umm/ what **I want**	maximum, absolute, subjective
513 T	// **I want**	maximum, absolute, subjective
541 T	// OK so what **do you think**	maximum, absolute, subjective
583 T	// **I don't understand** why not	maximum, absolute, subjective
584 T	// because this is **in fact** a cheaper calculator [than the F eight hundred]	maximum, absolute, objective
586 T	// **I would think**	median, probable, subjective
630 T	// [[what **I want** [[you to do just [for five minutes]]]]] is [[to prove [to me] [[that you can actually do these two questions]]]]	maximum, absolute, objective
631 T	// OK the first one **I don't really want**	maximum, absolute, subjective
644 T	// if **you 're not sure**	maximum, absolute, subjective
655 T	// **I think**	maximum, absolute, subjective
682 T	// **I reckon**	maximum, absolute, subjective
706 T	// **I sometimes think**	maximum, absolute, subjective
709 T	// **I don't think**	maximum, absolute, subjective
718 T	// **I wonder**	maximum, absolute, subjective
726 Se	// **I don't know**	maximum, absolute, subjective
764 T	// because **I think**	maximum, absolute, subjective

780 T	// so **I 'd like**	median, probable, subjective
783 T	// **I think**	maximum, absolute, subjective
790 T	// and then **I want**	maximum, absolute, subjective
794 T	// **what do you think**	maximum, absolute, subjective
800 T	// **if you like**	maximum, absolute, subjective
802 T	// **what you think**	maximum, absolute, subjective
813 T	// **I don't want**	maximum, absolute, subjective
836 T	// so Jenny just tell us any letter [[**you like**]] [for the first one]	maximum, absolute, subjective
921 T	// **I 'm still surprised**	maximum, absolute, subjective
937 T	// **I think**	maximum, absolute, subjective
958 T	// **I think**	maximum, absolute, subjective
966 T	// **I 'm sorry**	maximum, absolute, subjective
968 T	// **I know**	maximum, absolute, subjective
973 T	// **I <I> think**	maximum, absolute, subjective
980 T	// **I mean**	maximum, absolute, subjective
1004 T	// **if you like**	maximum, absolute, subjective
1044 T	// tell me any letter [[**that you like**]]	maximum, absolute, subjective
1050 T	// alright **if you want**	maximum, absolute, subjective
1060 T	// so what would **you like**	median, probable, subjective
1071 T	// because **we don't know**	maximum, absolute, subjective
1092 T	// [[what **I 'd like** [[you to do tonight]]]] is [[to finish that one and [[do number five]]]] please	median, probable, subjective

As for each lesson, the values for modulation are high with respect to obligation as seen in Table 6.15. In Lesson B, however, it should be remembered that there are twenty seven cases of low values realised as potentiality through "can". These arise in part from the metaphorical realisations of commands. In addition, the orientation and range of values of modulation show more variation than Lesson A.

Table 6.15 Obligation: Modulation

ORIENTATION/ VALUE (n = 106)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal	1 (0.9%)		94 (88.7%)	
High	4 (0.9%)		1 (0.9%)	
Medium			3 (2.8%)	
Low			3 (2.8%)	

The values for inclination as displayed in Table 6.16 are predominantly medium as realised by selections for future tense realised by "will" .

Table 6.16 Inclination: Modulation

ORIENTATION/ VALUE (n = 20)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal	3 (15.0%)		1 (5.0%)	1 (5.0%)
High				
Medium			8 (40.0%)	7 (35.0%)
Low				

It is evident that with respect to interpersonal metaphor realised through modality and modulation, Lesson B has the highest incidence found in any of the four lessons. Given that this type of metaphor creates some degree of uncertainty, it appears that this is one aspect of the patterns of deference that are particular to female students. As will be seen in Chapters Seven and Eight, other patterns of deference are found in Lessons C1 and C2.

Information relating to the selection of Mood Adjuncts in Lesson B is given in Table 6.17 below. The ratio of Mood Adjuncts per ranking clause in Lesson B is comparable to Lesson A and significantly greater than that for Lessons C1 and C2. It appears that this technique of interpersonal flavouring occurs in greater strength in Lessons A and B with the major difference being the taste. While both are concerned with lowering the intensity of the discourse, Lesson B is not as such concerned with high levels of presumption. Rather, the emphasis as reflected in Mood Adjunct selections is orientated towards low levels of probability and the establishment of facts, time and degree. This is significant given that Lesson B is a review lesson where perhaps high levels of presumption could reasonably function to flavour interpersonal meaning. Further to this, thirty nine or 31.0% of Mood Adjuncts in Lesson B are thematic. This indicates that the foregrounding of interpersonal meaning as the point of departure for the message is greater in Lesson B than any of the other lessons.

Table 6.17 Mood Adjuncts

	Total	Percentage (1 d.p.)
MOOD ADJUNCT	126	100
Intensity	69	54.8
Degree	11	8.7
Time	17	13.5
Presumption	4	3.2
Probability	19	15.1
Usuality	6	4.7
Ranking Clauses	123	97.6
Rank-shifted Clauses	3	2.4
Mood Adjuncts per ranked clause (n = 1067)	$\frac{126}{1067} = 0.12$	
Thematic Mood Adjuncts	39	31.0
Student contribution	4	3.2

The highest number of Comment Adjuncts are found in Lesson B. As seen in Table 6.18, these relate to 'seriousness' and 'fortune'. No such comments are found elsewhere.

Table 6.18 Comment Adjuncts

Clause N°/ Speaker	Clause
31 T	// **seriously** guys can we just
66 T	// **seriously** we 've got to understand this today [in the next fifteen minutes]
125 T	// **now unfortunately** I 've got a bit of a mix up here [in symbols]
321 T	// **now unfortunately** when you get [to year twelve]
323 T	// **not unfortunately** but you do complex numbers [in year twelve]
582 T	// **no unfortunately** the F eight hundred doesn't

As for each lesson, the Polarity is overwhelming positive as may be seen from Table 6.19. Being positive even in the face of adversity seems to be the name of the game.

Table 6.19 Polarity

POLARITY	Total	Percentage (1. d.p.)
Total	938	100
Positive	913	97.3
Negative	25	2.7

The orientation and classification of the lexical items of address, fixed expressions, colloquialisms, slang terms, anaphoric nouns and attributes, attitudinal lexis, amplification and others is summarised in Table 6.20. As for each lesson, the orientation of the majority of lexical items is neutral. The variety of lexical items that function covertly in Lesson B, however, is greater than that found in Lesson A. It may be recalled that in Lesson A, there were nine cases of the Vocative "people" classified as covert. The greatest range and incidence of covert items, however, is found in Lesson C1.

Table 6.20 Orientation of lexical items

	Total	Percentage (1. d.p.)
LEXICAL ITEMS	282	100
NEUTRAL	217	77.0
OVERT	36	12.8
Positive	31	
clined	26	
laudatory	5	
Negative	5	
clined	5	
condescending		
critical		
COVERT	29	10.3
Euphemism	28	
straight-euphemism	28	
dysphemic -euphemism		
Dysphemism	1	
straight-dysphemism	1	
euphemistic -dysphemism		

Lesson B has the greatest number of lexical items functioning as overtly positive. The female students receive greater direct praise than other

students. In addition, apart from Lesson C1, euphemistic expressions are most commonly realised in Lesson B. Euphemistic expressions and possible congruent translations are listed in Table 6.21.

Table 6.21 Euphemistic expressions

Clause N° / Speaker	Euphemism	Congruent expression
5 T	thanks	it is about time you paid attention
18 T	guys	girls
31 T	seriously	stop being silly
31 T	guys	girls
33 T	guys	girls
34 T	guys	girls
66 T	seriously	stop being silly
69 T	thanks	it is about time you paid attention
69 T	guys	girls
94 T	Steph	Stephanie
125 T	a bit of a mix up	mistake
158 T	Steph	Stephanie
164 T	<Fie>	Fiona (?)
177 T	guys	girls
195 T	a funny name	complex
202 T	Fran	Frances (?)
258 T	I want an answer [for this]	answer me
258 T	guys	girls
261 T	you guys	girls
288 T	a bit of trouble	difficulty
293 T	you guys	girls
330 T	got side tracked	moved off the topic
408 T	[for you guys	girls
504 T	I can get your attention [back again] [for a second]	be quiet
505 T	you guys	girls
921 T	surprised	dismayed
969 T	a lot of fun	not a lot of fun
1093 T	a little hesitant	don't know

Apart from one dysphemic expression "sack" in "you had better sack him" (clause 30), covert expressions function to case a positive glow on what could be said a more directly negative or neutral manner. As seen in Table 6.21, many covert items function as Vocatives. In Lesson B, however, there is a tendency not to neutralise sex as found in the Vocative "people" in Lesson A, but rather to appropriate the opposite sex to the female students. That is, the teacher addresses students colloquially as males through the Vocative "guys". I have classified this form of address as a euphemism because of its colloquial and 'friendly' orientation. This is interesting as it appears that in

single sex classrooms there is a tendency to subvert sexuality through covert forms of address. Perhaps this is one form of diffusing the tensions that arise in classrooms that are organised on the basis of biological sex. Other euphemistic forms of address in Lesson B are hypocorisms or diminutives which are later discussed in more detail with respect to overall choices of Vocatives.

Euphemisms such as "a bit of a mixup" (clause 125), "a bit of trouble" (clause 288) and "hesitant" (clause 1093) are concerned with mistakes or difficulties while others are metaphorical realisation of commands such as "thanks" and "I want an answer for this". It appears that rather than direct interpersonal relations, in Lesson B multiple strategies function covertly to ultimately realise a deferential position.

Surges of interpersonal meaning through amplification are most common in Lessons B and Lesson C1. The incidence of the different forms of amplification realised in Lesson B are listed in Table 6.22.

Table 6.22 Amplification of general lexical items and register specific items

	Total	Percentage (1. d.p.)
AMPLIFIED LEXICAL ITEMS	18	100
Intensification	18	100
straight intensification	18	
hyperbole		
understatement		
Iteration	0	0
VARIETY	17	94.4
Standard	12	
Colloquial	5	
REGISTER- mathematics	1	5.6

There are eighteen lexical items which involve intensification, one of which is a register specific lexical item. These items include expressions such as "so hard" (clause 24) "so concerned" (clause 39), "too much" (clause 58), "exactly the same" (clause 115), "a lot more sense" (clause 182), "a bit more sense" (clause 809), "very convenient" (clause 366), "very safe" (clause 421), "very

mean" (clause 691 and 693) a particularly good calculator (clause 612), "an extra long weekend" (clause 673), "a big problem" (clause 708) and "a little hesitant" (clause 1093). Such intensification through amplification does not occur in Lesson A where there is greater consistency in interpersonal relations.

Lexical items which realise attitude are most common in Lesson B. There are thirty five such items as seen from Table 6.23. Further to this, there are a greater range of attitudes realised in Lesson B than any other lesson. In addition to the Comment Adjuncts, these items include the majority of the lexical items which realise an overt positive or negative stance in addition to those that express some type of feeling. Largely the items realise a positive attitude as realised through "good" (clauses 214, 253, 275, 296 and 453 for example), "terrific" (clauses 14, 60 and 498) and "great" (clause 589). Negative feelings are realised through "unfortunately" (clauses 125, 321, 323 and 582) and "very mean" (clauses 691 and 693) while others generally express concern, seriousness, convenience and ease. In particular, the convenience aspect is referred to as "nice and convenient" (clause 368). This reference to pleasantness resurfaces as "nice" in "but it's nice to have these added little features" (clause 621-622). As seen from these examples, amplification intensifies the attitudes which are realised. Significantly, these attitudes are orientated towards feelings such as 'pleasantness', 'meanness' 'wonder' and 'fortune'. These function interpersonally to realise helplessness and deference.

Table 6.23 Attitudinal lexis

	Total	Percentage
Items	35	100
Variety		
Standard	35	100
Colloquial	0	

Of the eighty one Vocatives realised in Lesson B, sixty function as interpersonal components of the Theme and twenty one are Vocative Adjuncts. Although the number of Vocatives per ranking clause is proportional to those occurring in Lessons A, B and C1, more function as Vocative Adjuncts in Lesson B and C1. This means that personal address is less directly foregrounded in Lesson B. This suggests that personal responsibility and individuality is not as strongly promoted in Lesson B. It

appears that in some cases the Vocative functions as an afterthought when extra interpersonal emphasis is required.

As seen below in Table 6.24, nearly thirty five percent of Vocatives in Lesson B are non-names. Of these, seven colloquial terms of address are realised through "guys". Although comparable with Lesson C1, the highest incidence of hypocorisms is found in Lesson B. These include "Libby", "Steph", "Fie", "Fran", "Tammy" and "Jenny". These forms of address realise less formality and greater intimacy in the interpersonal relations of Lesson B.

Table 6.24 Forms of address

ADDRESS	Totals	Percentage (1 d.p.)
Total	81	100
Standard	74	91.4
Colloquial	7	8.6
REAL NAME	53	65.4
given		
surname		
full-name	43	
hypocorism	10	
nick-name		
NON-NAME	28	34.6
pronoun	2	
title	3	
formal		
kin-term		
solidarity		
leadership		
general noun	22	
occupational		
client		
group	1	
attitudinal		

While the highest incidence of colloquial expressions is found in Lessons C1 and C2, Lesson B contains significantly more than Lesson A. As displayed in Table 6.25 below, the majority are general colloquial expressions. In addition, one slang term, "sack" (clause 30), is realised. As well as realising less formal relations, these items function to realise patterns of deference.

Table 6.25 Colloquial expressions

Nature of Colloquial Expression	Total	Percentage (1 d.p.)
	85	100
FIXED EXPRESSIONS	5	5.9
Discoursal - social formula	3	
Discoursal - structuring		
Catch phrase	2	
VARIABLE EXPRESSIONS	80	94.1
General	61	
Address	7	
anaphoric attribute	2	
anaphoric noun	1	

The fixed expressions realised in Lesson B are categorised in Table 6.26. The number of such expressions is second only to Lesson C1. The items include catch phrases and cliches such as "it doesn't matter" (clause 190), "in our head" (clause 922), "sounds good" (clause 495) "in the long run" (clause 1073), "have another go at it" (clause 763) and "I'll give you a minute" (clause 788). I believe these items realise a position of deference as these types of expressions may be seen to operate as facets of a restricted code.

Table 6.26 Fixed expressions

Nature of Fixed Expression	Total
VARIETY	16
Standard	11
Colloquial	5
Slang	0
CATEGORY	
1. catch-phrase	6
2. cliche	6
3. idiom	1
4. proverb	
5. quotation	
6. discoursal	3
social formula	3
structuring	
comment adjunct	
gambit	
stylistic form	
stereotype	

There are six cases of anaphoric nouns in Lesson B with one colloquial item, "a bit of a mix up" (clause 125). The occurrence of anaphoric nouns is second to Lesson A, but there is a marked difference in the function of these items. In Lesson A, the items are overtly positive and replace direct attitudinal comment as illustrated by "good suggestion" instead of "good". However, in Lesson B, with the exception of "a good point" (clauses 98 and 116), the items function covertly as euphemisms for mistakes and difficulties as seen in Table 6.27. Although admittedly somewhat submerged in this particular example, once again there is nevertheless a directness in the tenor relations in Lesson A that is nowhere matched in Lesson B .

Table 6.27 Anaphoric nouns

Clause N^{o}/ Speaker	Clause
98 T	// OK that 's **a good point**
116 T	// alright and ah/ Stephanie had **a good point** before
125 T	// now unfortunately I 've got a bit of **a mix up** here [in symbols]
708 T	// but it 's not **a big problem**
962 T	// there 's **a little bit of confusion**
979 T	// what 's **the confusion**

As for Lesson A, apart from dealing with 'correctness' or 'incorrectness' as, for example, in "[that's] right" (clause 991) and '[we are] correct" (clause 1023) and "[we're] wrong" (clause 983), the fourteen anaphoric attributes realised in Lesson B are largely related to mathematical content and deal with ease and convenience. In addition, however, in Lesson B there seems to be some concern about the level of 'complexity', the amount of 'sense' something makes and the levels of 'safety' as illustrated respectively by the following clauses.

123 T // that looks complicated doesn't it
182 T // that would make a lot more sense
421 T // that 's not very safe

The number of 'other' lexical items realising interpersonal meaning in for Lesson B is less than that found in Lesson C1 and C2 but exceeds the number realised in Lesson A. This may be explained by the frequency of colloquial items which do not fall into the categories which have already been discussed. In addition, however, there are specific varieties of lexical items which do not occur in other lessons. Apart from standard colloquial

expressions such as "reckon" (clause 94 and 293) and numerous incidences of "yeah" (clause 137, 229, 351, 404 for example) these include items such as "a funny name" (clause 195), "a little bit more adventurous" (clause 642) and "safe" (clauses 423, 432, 435). These lexical choices function to realise patterns of deference that are almost analogous to those found in interactions with children.

Interpersonal metaphor is largely realised through incongruence between the systems of SPEECH FUNCTION and MOOD and plays with modality and modulation. However, two examples of grammatical metaphor realising interpersonal meaning are given in Table 6.28. There are a total of nine instances in the discourse where modality is expressed as an entity in the form of "possibility". In the case of "confusion" the metaphor operates to construct an entity from the process of 'confuse'. If this process were congruently realised, the students would be the Medium. Through interpersonal metaphor, responsibility is thus directed away from the students through the creation of a new nuclear configuration consisting of an Existential process and an Entity. This deflecting of personal responsibility is explicitly realised through teacher comments such as "You didn't know how to do it before. Well maybe that's because we rushed it last week" (clauses 48-50). This contrasts sharply with Lesson A where personal responsibility is directly expressed.

Table 6.28 Grammatical metaphor and interpersonal meaning

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause: **INTERPERSONAL**	
process —>	**entity** (nominal group)
can/could/may/will confuse	322 T // it is **a possibility** 962 T // there 's **a little bit of confusion**

6.232 Tenor

The tenor relations realised in Lesson B conflict with those found in mathematical discourse. Unequal tenor relations operate both overtly and

covertly in the oral discourse to realise patterns of deference. Although the teacher's position of dominance is evident form his speech role of primary knower and secondary actor, his linguistic choices function covertly to realise a position of deference.

Interpersonal metaphor as opposed to interpersonal congruence is realised in the selections of MOOD realising the SPEECH FUNCTION. Commands are covertly issued and there is a relatively high incidence of tagged declaratives. The students learn to reproduce these patterns as evident in the clause below. A pattern of deference is obvious in the student request for the teacher to adjust the overhead projector screen. Apart from the selection of a polar interrogative Mood, the command is tagged with "please" and accompanied by the deferential Vocative Adjunct "Mr X".

757 S can you put it up a bit please Mr X ..

On average, due to minimal Dynamic moves and clause complex relations, the exchanges are the shortest found in all four lessons. Student responses to questions are not extended and often involve ellipsis. In addition to paralinguistic behaviour, chorus responses are accepted.

Microgenres such as Student Interruptions and Teacher Disciplinary Interruption realise surges of interpersonal meaning. However, students do not interrupt in order to challenge, question or clarify the mathematics. Instead interruptions function to introduce new fields such as 'rowing' and 'homework' with the latter ultimately not being a request for help but rather introduction of the male tutor. In the few instances that students do adopt the role of primary knower, as they do more often in Lesson B than any other lesson, it appears that the students are exercising power. While this may be true in the context of the classroom, given the field of the discourse it is questionable as to whether this leads to dominating relations in any real sense of the word. Although the teacher's position is contested by the students in a manner not found in Lesson A, his position is not really threatened. The position of the students is perhaps best indicated by the teacher's comment "seriously guys can we just... can we now just get on with the work" (clauses 31-32). This lack of seriousness about the activity of learning mathematics is not found in Lesson A.

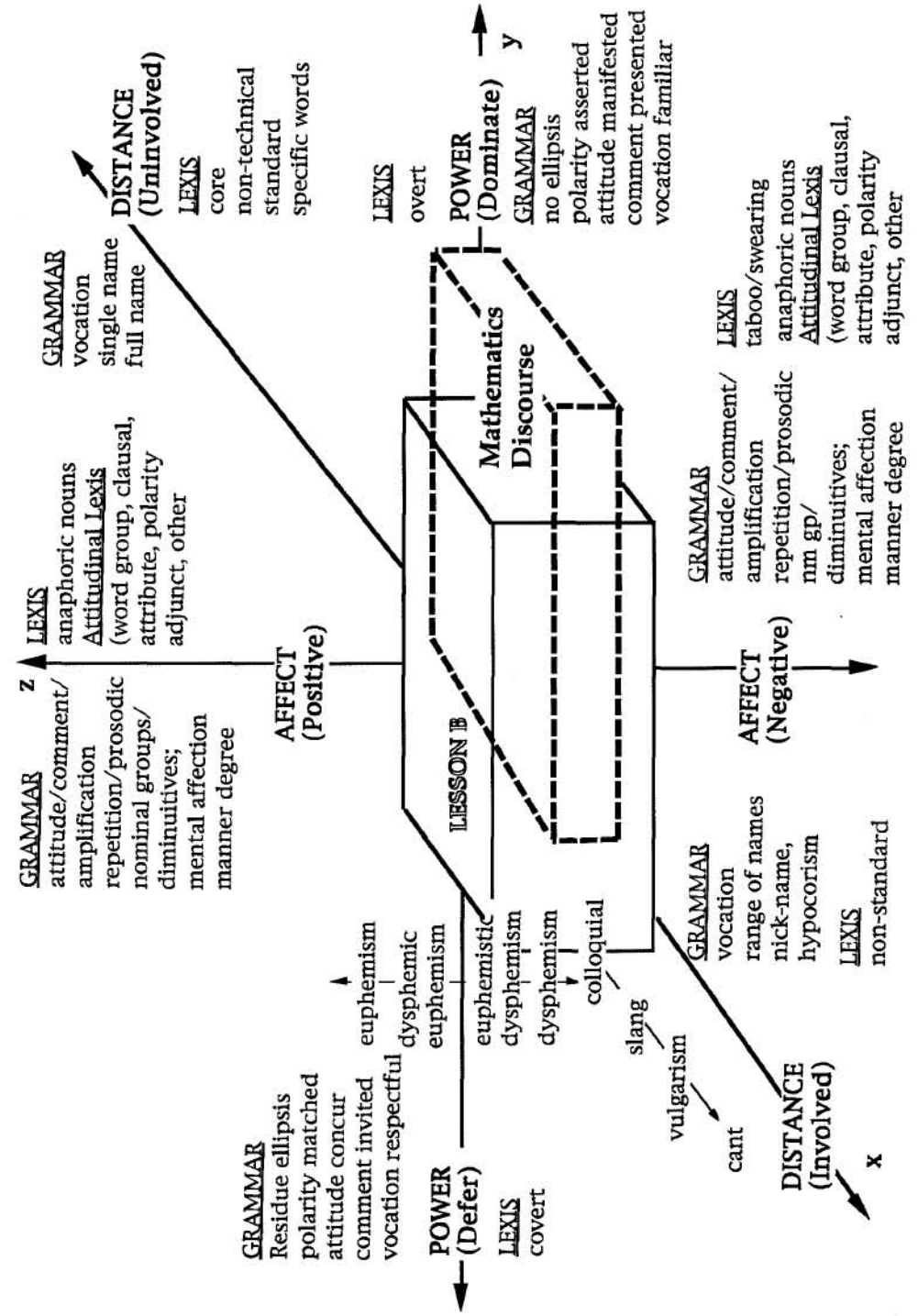


Figure 6.7 Lesson B - Tenor Dimensions

When student behaviour is unacceptable, the teacher's disciplinary actions are not direct but on the contrary involve interpersonal metaphor. That is, the teacher covertly manipulates the students while maintaining an aura of pleasantness, patience, cooperation and tolerance. These attributes, together with safety and convenience, are promoted throughout the entire lesson in part through lexical choice. In addition, although comment is presented, it is not always direct. Covert lexical items realised as euphemisms and other lexical choices realise patterns of deference.

Vocation tends to be familiar and intimate through choices of hypocorisms for names and colloquial forms of address. Although the teacher's overt position of dominance is evident from "Mr X", other linguistic patterns function to reduce the formality of the lesson. In addition to colloquialisms, affect is manifested through attitudinal lexis and amplification.

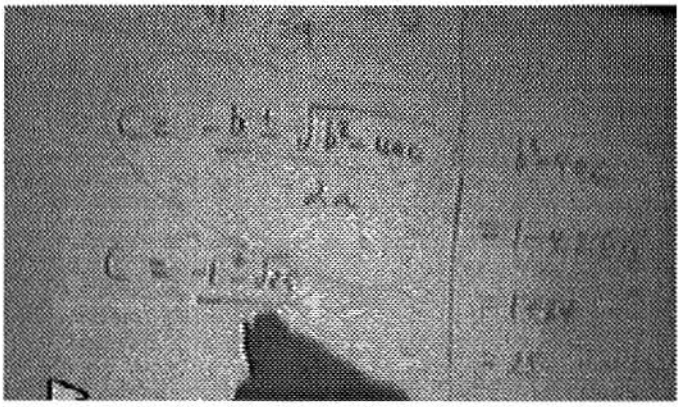
The interpersonal relations could be described as circular eddies which peak in terms of interpersonal meaning but dissipate. In the context of western culture, foregrounding interpersonal meaning in the manner realised in Lesson B ultimately leads to a dead end. These students, while managing to wield some power within the classroom setting, ultimately are not learning strategies of dominance. As seen in Figure 6.7, the location of the oral discourse of Lesson B with respect to mathematics discourse results in a mismatch in all dimensions. As seen in the analysis of the board text, certain dimensions of this mismatch are replicated.

6.233 The Mathematical Text

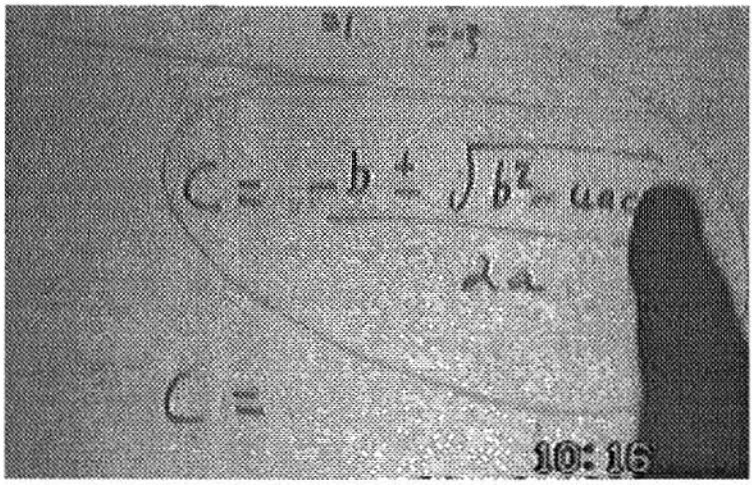
The general features of the symbolic board text are observable in Scenes 6.1 to 6.6 below. What becomes immediately apparent is that the immaculate style of production found in Lesson A is not replicated in Lesson B. This may in part be explained by the differing goals of the lesson. In Lesson B the teacher is not presenting new course content but is reviewing work that has already been taught. In striving to highlight central concepts, the teacher uses visual strategies to focus attention. These strategies involve visual semiotics such as lines, circles, arrows, boxes and diagonal lines which are not found in generic symbolic mathematical texts.

In Scene 6.1, it may be seen that the teacher has drawn freehand lines to divide the overhead screen into different sections. This serves to compartmentalise the different activities associated with solving the problem and to focus attention at particular stages. As displayed more clearly in Scene 6.2, the quadratic formula has been circled for prominence. In this particular clip, the teacher is also directing the students attention to a particular part of the quadratic formula through gesture.

Scene 6.1 The board text - View 1

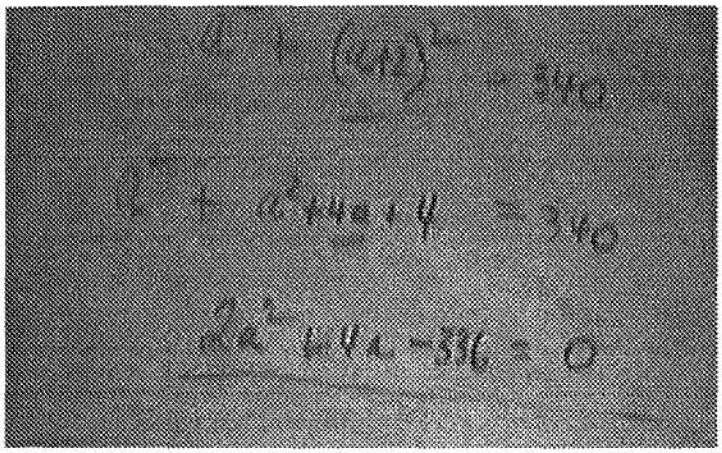


Scene 6.2 The board text - View 2

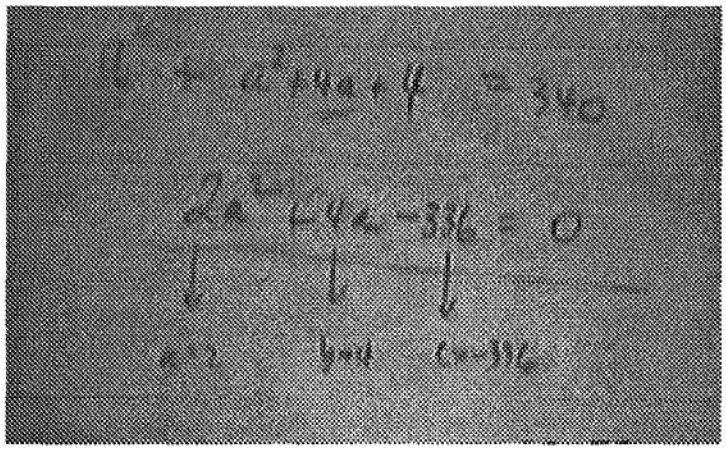


In Scenes 6.3 and 6.4, other modal strategies for focussing attention are realised. These include underlining the key participants and statements and using arrows to direct the viewer's gaze to pairs of corresponding participants. Unlike Lesson A, however, colour is not employed as a modal strategy.

Scene 6.3 The board text - View 3

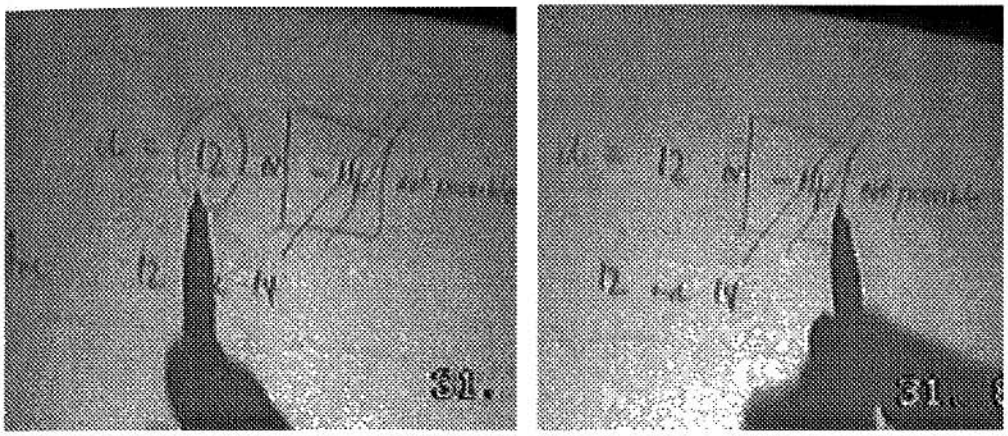


Scene 6.4 The board text - View 4



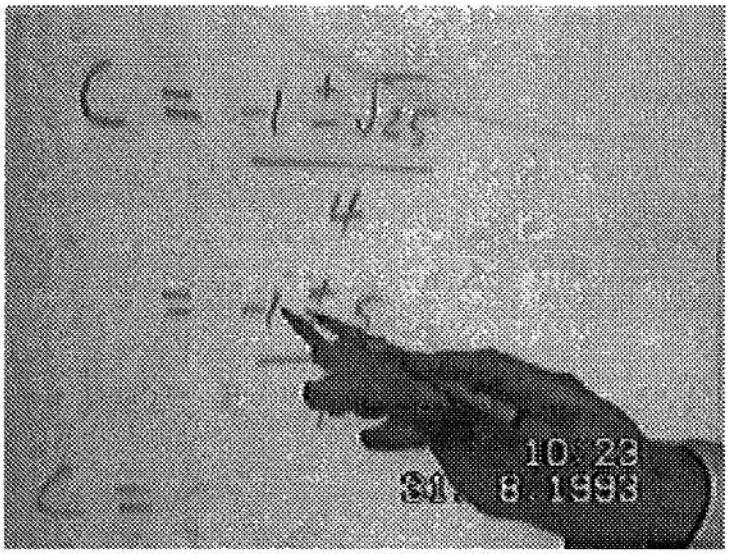
The two solutions "12" and "-14" in Scene 6.5 are marked by a circle and a box respectively. Further to this, the box has two diagonal line segments drawn through it and a corresponding linguistic label "not possible". This is the most striking example of visual semiotics which are employed to realise interpersonal meaning in the symbolic text. Diagonal or crossed lines realise negative polarity of a command as in the case, for example, "no smoking". In this case, the diagonal lines mean "this is not a solution".

Scene 6.5 The board text - View 5



As for each lesson, gesture plays an important role in realising interpersonal meaning. Attention is focussed through pointing to particular participants in the mathematical text as shown in Scene 6.5 above and again in Scene 6.6.

Scene 6.6 The board text - View 6



The freehand style of production of the symbolic text together with the incorporation of visual cues means that interpersonally the visual display realises less dominating and more informal relations than found in generic mathematical texts. In essence, the interpersonal relations found in the oral discourse are replicated in the visual display. This seems to be a trait that is common to the lessons in this study.

A drawing of the complete visual text is reproduced below in Figure 6.8. and labelled #A to #H. According to the classifications given in Chapter 4, the these texts are 'solving problems' genres consisting of mathematical problems followed by the solutions.

#Ai

Solve

$2c^2 + c - 3 = 0$

a b c

=2 =1 =-3

$$c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

c =

Discriminant

$(b^2 - 4ac)$

① Number of Solutions

1 Solution if

$(b^2 - 4ac) = 0$

② 2 Solutions if

$(b^2 - 4ac) > 0$

③ No Solutions if

$(b^2 - 4ac) < 0$

#Aii

Solve

$2c^2 + c - 3 = 0$

$= 0$

a b c

$=2 \quad =1 \quad =-3$

$$c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$(b^2 - 4ac)$
$= 1 - 4.2.(-3)$
$= 1 + 24$
$= 25$

$$c = \frac{-1 \pm \sqrt{25}}{4}$$

$$= \frac{-1 \pm 5}{4}$$

$c = 1$ or $c = \frac{-6}{4}$ or -1.5

#B

Solve

$b^2 - 4ac$

$3p^2 + 4p - 1 = 0$

$$p = \frac{-4 \pm \sqrt{28}}{6}$$

#C

$ax^2 + bx + c = 0$ $\quad a = 3 \quad b = 4 \quad c = -1$

0.2152... $\quad$ -1.5485...

#D

(1.) For $4y^2 - 6y + 3 = 0$

How many solutions are there?

(2) Solve

$\frac{3}{2} m^2 - \frac{1}{5} m - 1 = 0$

$m = -.7525$ or $m = .8859$

#E

a a + 2

$a^2 + (a+2)^2 = 340$

$a^2 + a^2 + 4a + 4 = 340$

$2a^2 + 4a - 336 = 0$

a = 2 b = 4 c = -336

#F

2b, 5

#G

a = (12) or ~~-14~~ not possible

a + 2 = 14

Ans. 12 and 14 ✓

#H

-x , -x - 3

-x , -x + 3

-x (-x + 3) = 20

x^2- 3x - 20 = 0

Figure 6.8 The board text

The prominence of the visual cues becomes apparent in these reproductions. In particular, the division of the text into separate spatial compartments is a prominent feature of the texts labelled #Ai and #Aii. This is perhaps a poor reflection of the textual organisation of mathematical textbooks where important results are framed in boxes and text is aligned in separate columns and paragraphs. However, as seen in sections 6.243 and 6.263, this strategy complicates textual and logical meaning through the creation of loops in the reference and implication chains.

The underlining of the imperative command "solve" in #A and #B and the labels on the right hand side focuses attention respectively on the command and the summary of results which are used. The circled and numbered elements of the summary on the right hand side are later replaced with a calculation as shown in #Aii. In the upper portion of the text in #A and #E, the arrows function modally to link the coefficients of each term in the expression with the corresponding value in the quadratic formula. In addition, the solutions to the problems are underlined for modal significance. The other problem is realised through a WH-interrogative. This interrogative is a case of interpersonal metaphor for the imperative command "find the number of solutions".

The symbolic text consists solely of non-modalised declarative statements. The participants are variables and numerical values and the processes are Operative. At odds with the oral text and the visual cues, the symbolic text realises power dominating relations.

Although this board text must be analysed in the context of the review lesson in which it was constructed, several features are significant. Firstly,

less dominating relations are realised through the informal freehand style of production. This is reinforced by the visual cues which are used to direct attention. In addition to the textual function of separating the board into clearly marked sections, the geometric 'figures' function modally to focus on features of the text rather than expand experiential meaning. It would have been possible for the teacher to link the algebraic solutions to the quadratic equations to graphical display. These features contrast with the power dominating relations realised through modal congruence in the symbolic text.

The visual display has features that are not typically found in generic symbolic texts. This includes freehand style and the use of circles and arrows for modal prominence. As seen in Chapter Eight where a view of student work is displayed, students tend to reproduce board texts as notes in similar styles to those which are realised by the teacher. One cannot but help think that a review lesson at School A would be very different.

6.24 Textual Meaning

Apart from the analysis of the general linguistic patterns, the discussion of textual, experiential and logical meaning illustrated through excerpts from Lesson B is confined to the microgenres with a field of mathematical course content. This includes the Preliminary Genre of Homework Discussion and the Main Lesson Genre of Board Demonstration.

6.241 General Lexicogrammatical Patterns, IDENTIFICATION and Textual Metaphor

The classification and nature of the Theme selections in Lesson B are summarised in Table 6.29 below. Lesson B has the highest percentage of unmarked Themes although the frequency is comparable to that found in Lesson C2. Although substantially lower, Lesson B has the second highest percentage of marked Themes after Lesson A. While the distribution of dependent and embedded Themes is roughly equivalent across all lessons, the frequency of ellipsed Themes is both significantly higher than Lesson A and lower than Lesson C1 and C2. The percentage of minor clauses is second to Lessons A and Lesson C1.

Table 6.29 Classification and components of Theme selections

	Total	Percentage
	1067	100
CLASSIFICATION OF THEME		
Unmarked	704	66.0
Marked	64	6.0
Dependent	47	4.4
Embedded	16	1.5
Ellipsed	135	12.7
No theme (minor clause)	97	9.1
Unknown	4	0.4
NATURE OF THEME		
No Thematic components		
Ellipsed topic	111	10.4
Minor clause or Non-finite dependent clause	69	6.5
Single Theme		
Ideational only	447	41.9
Multiple Theme	436	40.9
1. Ideational component	384	
Ideational/Textual	248	
Ideational/Textualx2	59	
Ideational/Textualx3	4	
Ideational/Interpersonal	29	
Ideational/Interpersonalx2	1	
Ideational/Textual/Interpersonal	36	
Ideational/Textualx2/Interpersonal	5	
Ideational/Textualx3/Interpersonal	1	
Ideational/Textual/Interpersonalx2	1	
2. No Ideational Component		
a. Ellipsed Topic	24	
Textual	21	
Interpersonal	1	
Interpersonalx2	1	
Textual/Interpersonal	1	
b. Minor/Non-finite Dependent Clauses	28	
Textual	7	
Textualx2	3	
Textualx3	1	
Interpersonal	13	
Textual/Interpersonal	4	

From these observations it appears that Lesson B is situated midway between the extremes of Lesson A and Lesson C1 and C2 with respect to textual organisation. Although at first glance Lesson B shows the least variation in

terms of Theme selection as evidenced by the high proportion of unmarked Themes, nevertheless proportionally there is slightly more variation as evidenced by the number of marked Themes. The gap is accounted for by the high proportions of ellipsed Themes in Lesson C1 and C2. While not as organised as Lesson A, the spoken discourse of Lesson B tends to reflect patterns in written discourse to a greater extent than Lessons C1 and C2.

Closer inspection of the nature of the Theme reveals that Lesson B follows Lesson A in terms of the lowest proportion of ellipsed topics. This difference is significant, however, with the rate of ellipsis in Lesson B being double that found in Lesson A. Lesson B also follows Lesson A in terms of the lowest percentage of single Themes and the highest percentage of multiple Themes. However, 8.7% (93 items) of the Themes in Lesson B contain at least one interpersonal element compared to 7.5% (53 items) in Lesson A, while 36.8% (393 items) contain at least one textual element compared to 45.5% (322 items) in Lesson A. This suggests that while Lesson B follows Lesson A in terms of the complexity of the Theme, choices function to foreground interpersonal meaning to a slightly greater extent in Lesson B than in Lesson A. Lesson A leads the way in terms of textual organisation as evidenced from the number of thematic textual components.

A summary of the nature of the field of the Theme is given in Table 6.30. Lesson B is the only lesson where the teacher and students are selected as the Theme more often than mathematical content. This is perhaps another indication of the prominence of interpersonal meaning in Lesson B at the expense of experiential and logical meaning. The interlocutors form the basis for the departure of the message. Given the relatively low percentage of marked Themes, the teacher and student more frequently form the Subjects in the MOOD system through which the modal responsibility is granted.

The lowest incidence of mathematical lexical items as Theme is found in Lesson B. Interestingly enough, the highest incidence of topics which are related to the mathematics class work occur in Lesson B. It appears that thematic selections operate to foreground the students and their work as opposed to the mathematical content of the lesson.

Table 6.30 Field of Theme

FIELD	Total	Percentage (1 d.p.)
	831	100
Teacher	75	9.0
Students	204	24.5
Teacher and students	57	6.9
TOTAL	336	40.4
Mathematical lexical item	72	8.7
Mathematics (WH-item)	76	9.1
Mathematics (TH-item)	44	5.3
Maths (pronoun)	37	4.6
Related to Mathematical class work	85	10.2
TOTAL	314	37.8
Student work	11	1.3
Action	59	7.1
Other	111	13.4

The incidence of rankshifted clausal and phrasal elements in Lesson B is displayed in Table 6.31. Teacher and student contributions are considered separately in Table 6.32.

The incidence of rankshifted clausal elements in Lesson B is comparable to Lesson A. The greatest number of rankshifted clausal elements occurs in Lesson C1 as the field selection for the dominant microgenre is algebraic expressions. As seen in Chapter 7, these expressions are notorious for rankshifted clausal elements. Despite this distribution, as displayed in Table 6.32, student clauses in Lesson A and B realise rankshifted clausal elements proportionally more often than those in Lesson C1 and C2. Given the absence of diagrammatic or graphical visual display, the percentage of rankshifted phrases is low in Lesson B.

Table 6.31 Clausal and phrasal rankshift

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	1063	100
Rankshifted Clausal Element (Total)	106	10.0
Rankshifted Clause and Phrase Elements	30	2.8
Rankshifted Phrase Only	155	14.6

Table 6.32 Clausal and phrasal rankshift: Teacher and student contributions

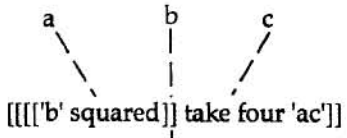
	Teacher		Student	
	Total	Percent-age	Total	Percent-age
CLASSIFIED CLAUSES (Total 1063)	941	88.5	122	11.5
RELATIVE PERCENTAGE	941	100	122	100
Rankshifted Clausal Element - Total	97	10.3	9	7.4
Rankshifted Clause and Phrase Elements	27	2.9	3	2.5
Rankshifted Phrase Only	143	15.2	12	9.8

At the level of discourse semantics, the reference patterns in the oral discourse intertwine with those found in the visual symbolic text in Lesson B. The example of the participant chains illustrated in Figure 6.9 therefore incorporates the symbolic text. As for each lesson, the ancillary and constitutive roles of the linguistic and symbolic codes and the spoken and visual modes alternate within the space of a few clauses.

Although not indicated as such in Figure 6.9, the reference patterns realised in the oral discourse are predominantly either exophoric or anaphoric. That is, the reference is either to the written text or to the preceding oral discourse or both. As mentioned in section 5.241, selections from the system of DEIXIS for mathematical participants are commonly not made with the variable functioning as a pronoun. As for Lesson A, repetition acts as a direct aid for tracking although this does lead to problems in clauses 125 to 127 in Lesson B. Here the teacher has two different participants called "c". Both the variable in the quadratic equation and the variable for the constant term in the quadratic formula are labelled as "c". The teacher clarifies this problem through gesture and appropriate selections from the system of DEIXIS as seen in the following excerpt.

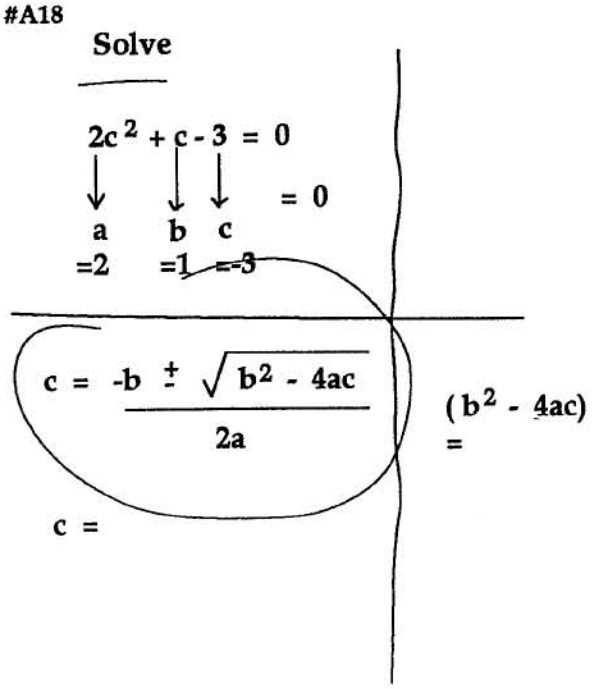
CONSTITUENT MODE: Aural (linguistic)
ANCILLARY MODE: Visual (symbolic)

343 T // so everybody [[[['b' squared]] take four 'ac']]



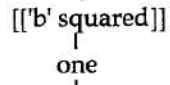
CONSTITUENT MODE: Visual (symbolic)
ANCILLARY MODE: Aural (linguistic)

#A18

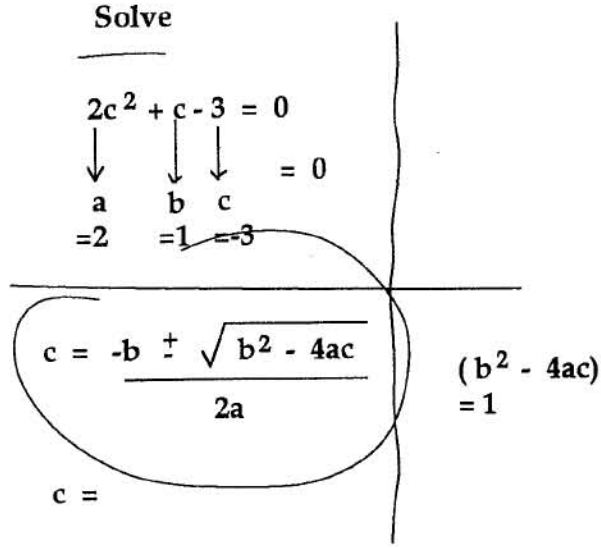


(b 2 - 4ac)
=

344 T // bit fuzzy
345 T // what 's [['b' squared]]
346 T // one



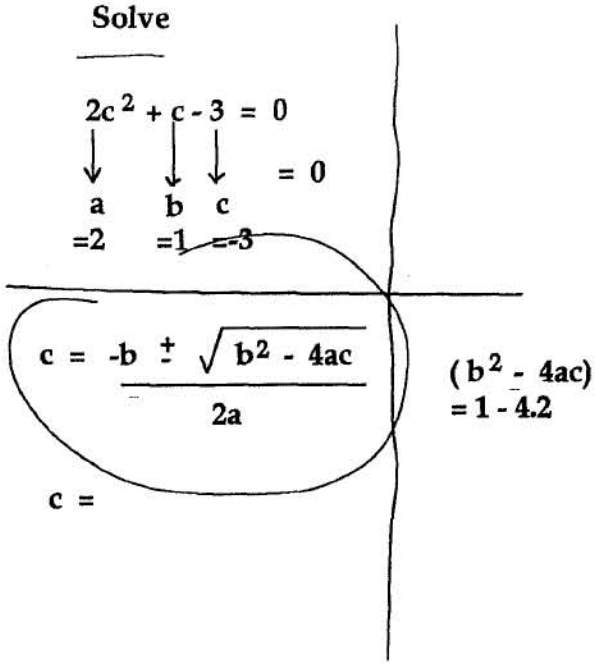
#A18

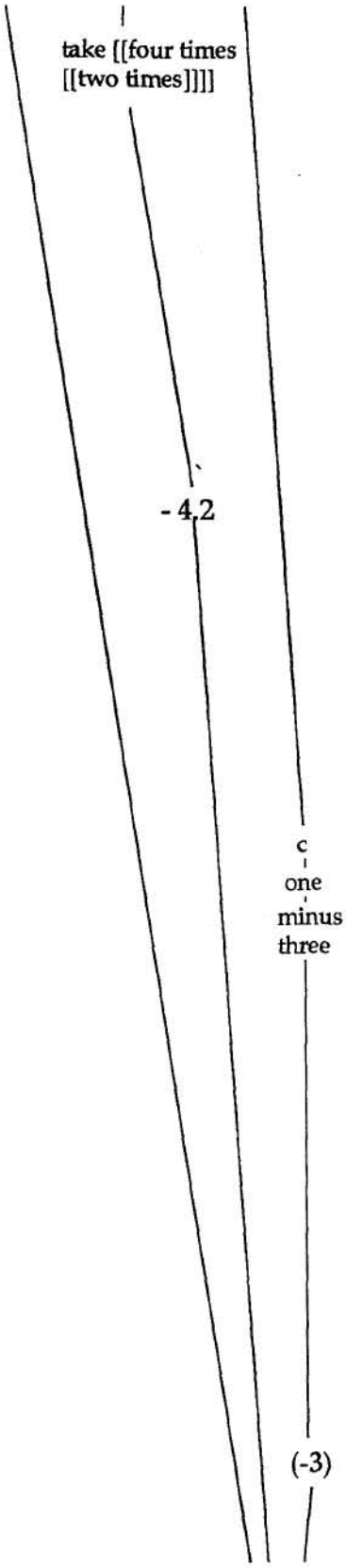


(b 2 - 4ac)
= 1

347 T // take [[four times [[two times]]]]

#A18



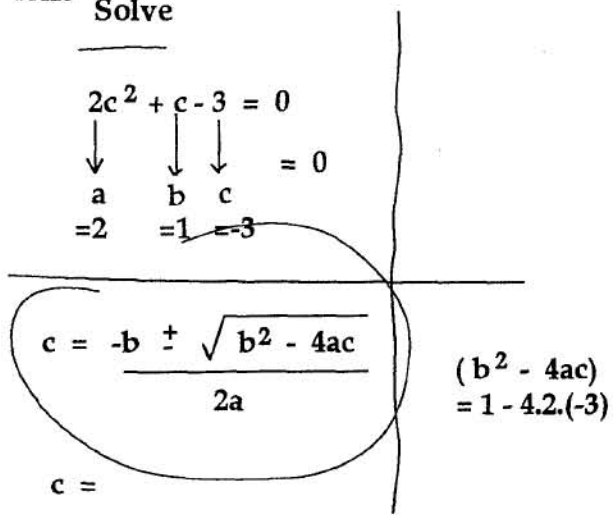


CONSTITUENT MODE: Aural (linguistic)
ANCILLARY MODE: Visual (symbolic)

348 T // what 's 'c'
349 S? // one
350 T // no it 's minus three actually isn't it
351 S? // oh yeah

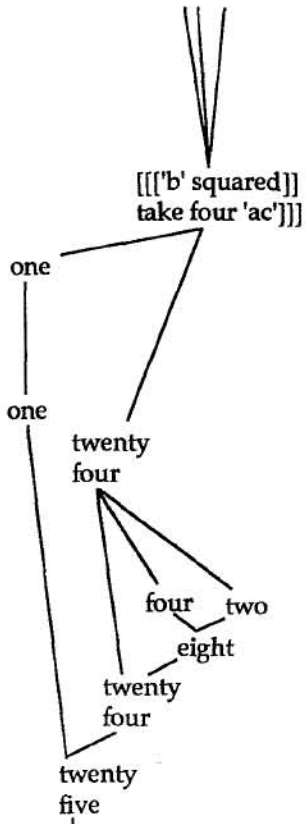
CONSTITUENT MODE: Visual (symbolic)
ANCILLARY MODE: Aural (linguistic)

#A18



CONSTITUENT MODE: Aural (linguistic)
ANCILLARY MODE: Visual (symbolic)

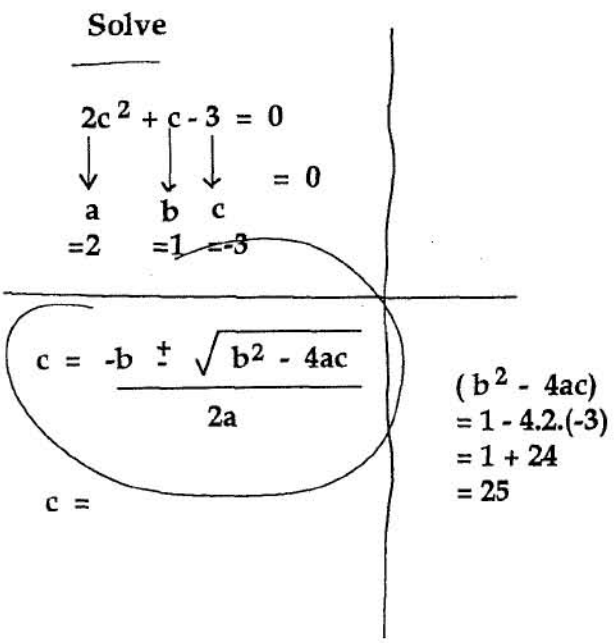
352 T // this is [in this question] there
353 T // what 's the answer[for [[[['b' squared]] take four 'ac']]]
354 T // it 's one
355 T // what 's two negatives make
356 S? // a plus
357 T // plus
358 T // so what 's the answer
359 T // one plus what
360 T // Helen
361 Hel// twenty four



CONSTITUENT MODE: Visual (symbolic)
ANCILLARY MODE: Aural (linguistic)

362 T // four two's
363 T // eight
364 T // you 're right
365 T // twenty four and
366 T // very convenient isn't it
367 T // twenty five

#A19



CONSTITUENT MODE: Aural (linguistic)
ANCILLARY MODE: Visual (symbolic)

368 T // why is twenty five nice and convenient
369 Ss // it 's a square
370 T // it 's a nice square number
371 T // so [up here] you can now put it in

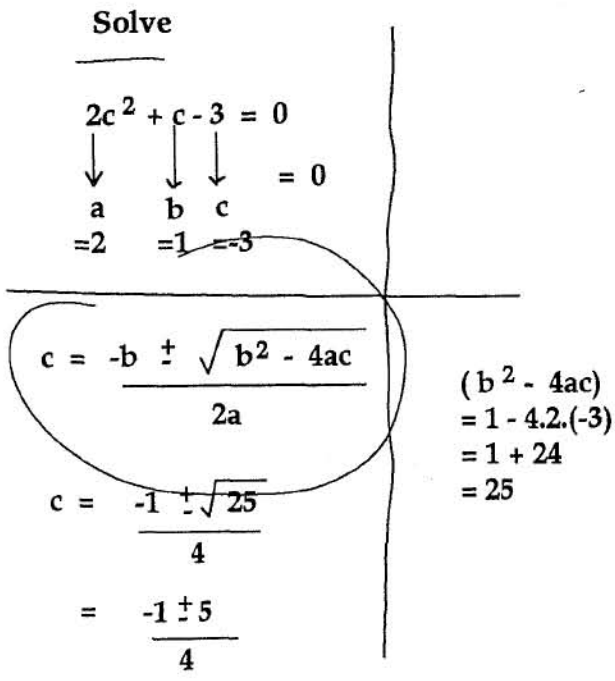
twenty five
it
it
it

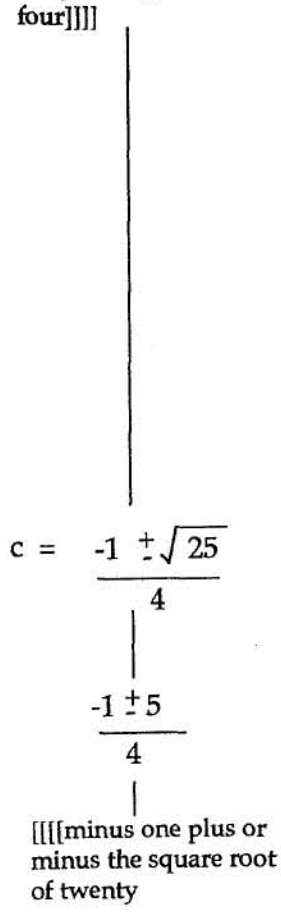
CONSTITUENT MODE: Visual (symbolic)
ANCILLARY MODE: Aural (linguistic)

372 T // you go [[[[minus one plus or minus the square root of twenty five]] over [[two twos are four]]]]

[[[[minus one plus or minus the square root of twenty five]] over [[two twos are four]]]]

#A20





373 T // so it comes out to be [[[[minus one plus or minus five]] on four]]

Figure 6.9 An example of the major reference chains

125 T // now unfortunately I 've got a bit of a mix up here [in symbols]
126 T // by calling them variables
127 T // the 'c' and this 'c' aren't the same

In general the reference patterns of Lesson B are simpler than those found in Lesson A as displayed in Figure 6.9. The reason is that in Lesson B the participants are not recombined into new nuclear configurations to the same extent as found in Lesson A. This is a function of the field of the discourse. In Lesson B the participants in the quadratic formula are substituted with numerical values. These numerical values are reconfigured through simplification as opposed to recombination. The simplification of the numerical values is performed according to the rule of order which is brackets, powers, multiplication/division addition/subtraction respectively. The level of complexity of the reference patterns is greatly lowered as the tracking of 'abstract' participants in the form of variables is replaced with numerical quantities which are simplified. In Lesson B as seen in section "6.243, The Mathematical Text" the teacher also adopts visual strategies as an aid for tracking in the written text. Given the transitions between the constituent and ancillary roles of the oral and visual mode, the visual strategies interface with gesture for tracking in the oral discourse.

Textual metaphor is not a prominent feature of the oral discourse in Lesson B though it does play a role. There are only six cases of anaphoric nouns to realise 'meta-message' relations. As the majority of these are euphemistic expressions such as "a bit of a mixup" (clause 125) and "a little bit of confusion" (clause 962), the function of these items is orientated more towards interpersonal meaning as opposed to textual meaning. Examples of textual metaphor in the form of 'text reference' are listed below. This seems to be a common form of textual metaphor in pedagogical discourse.

60 T // **that** 's terrific
77 T // so **that** 's going to work out (to be equal to zero)
98 T // OK **that** 's a good point
123 T // **that** looks complicated doesn't it
215 T // **that** 's exactly [[what it 's doing]]
275 T // **that** 's good isn't it

Negotiating texture which makes monologic discourse appear as dialogic discourse makes an appearance through the collective 'we' as epitomised by the following extract which was initially featured in this chapter.

411 T // OK what letter would we like best today
412 T // 'p'
413 T // 'p' squared

6.242 Mode

With respect to the Preliminary Genres and the Main Lesson Genres, the majority of the microgenres constituting Lesson B involve transitions between the visual and oral modes. Exceptions are Teacher Motivation, Teacher Disciplinary Interruption, Student Interruption, Classroom Business, Diagnostic Activity, Copying Notes, Teacher Exposition, Student Review Task and Seatwork, with the latter two often accompanied by oral discourse.

When the oral discourse is the constitutive mode, it involves 'construction' and 'generalisation' as for Lesson A. However, the oral discourse functions more often as an ancillary mode for the visual text in Lesson B. In this role, the function of the spoken mode is 'commentary' and 'co-observing'. Although the teacher questions the students as to the steps involved in the derivation of the solution to the problem, the minimum input of the student in Lesson B compared to other lessons indicates that apart from teacher construction, the oral discourse functions in an ancillary role as metadiscourse for the visual text. This role is suggested in the extract given in Figure 6.9 above. One explanation for this phenomenon is that Lesson A is orientated towards review of particular problems rather than construction of new concepts. However, the problem with an emphasis on the visual text is that students copy down what is written on the board with perhaps less thought than may be desired.

6.243 The Mathematical Text

The teacher employs textual strategies other than those found in generic texts as an aid for tracking. These strategies include various visual cues for organising the text as a message. In Figure 6.10 below, the arrows explicitly link participants in a manner that is analogous to those realised in reference chains. The values of the variable in the quadratic formula are thus directly linked to the coefficients in the quadratic equation.

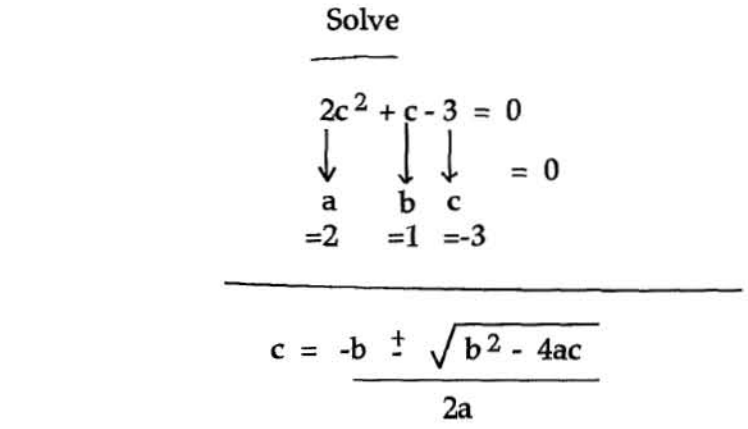


Figure 6.10 Visual aids for tracking participants

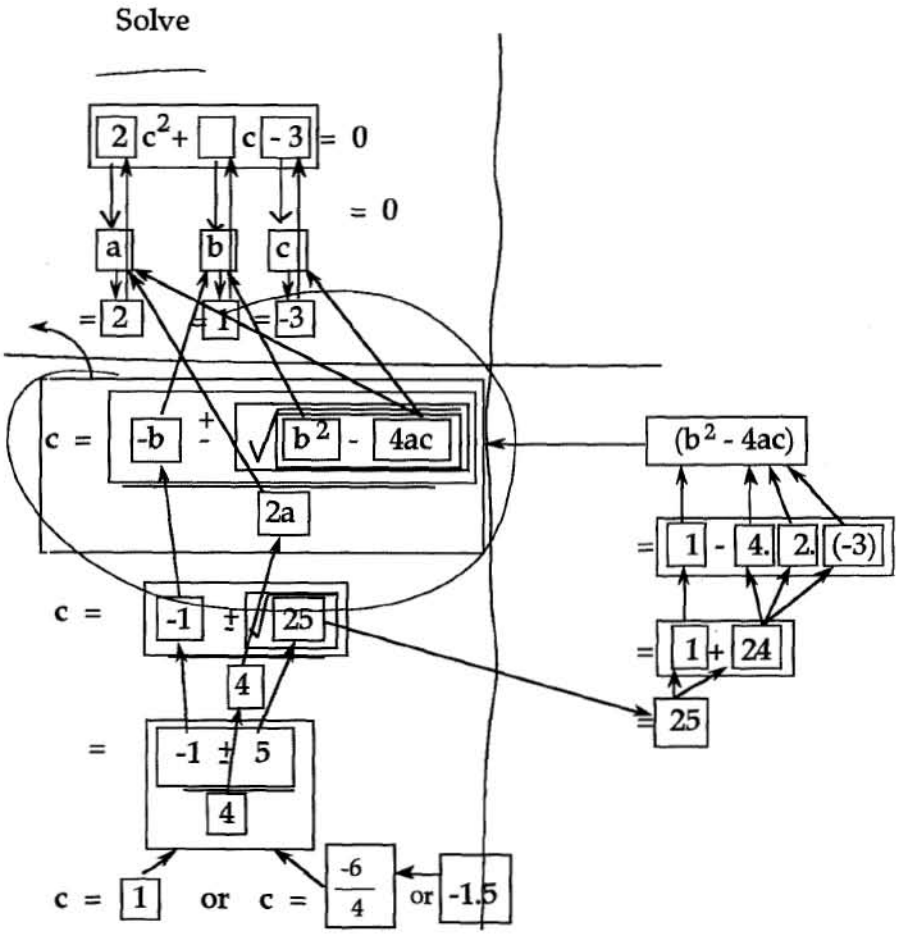


Figure 6.11 Major reference chains in the symbolic text

The teacher also divides the screen into compartments where various activities are completed. In Figure 6.11 above, the right hand side was devoted to calculating the value of the discriminant "b^2 - 4ac". This deviates from the textual organisation found in the generic form where the quadratic formula is stated, the values substituted and the solution stated in consecutive lines which are placed underneath one another. The Theme which is the variable of the quadratic equation is given in the first line and may be ellipsed in subsequent lines. According to the generic form, the Theme is restated when the final solution to the problem is given. In enlisting the strategy of spatially dividing the screen and calculating the value of the discriminate on the right hand side, the teacher is not replicating the generic structure of such a problem. This means that the important role of spatial positioning in realising textual meaning as found in generic texts is somewhat dampened in the Lesson B board text as seen in Figure 6.11. Instead of the anaphoric reference patterns pointing directly upwards, a loop is created by positioning the "b^2 - 4ac" on the right hand side. The teacher adopts this strategy in order to highlight the number of different solutions which result from the value of the "b^2 - 4ac" and to simplify the calculation within the main body of the text. Apart from differing generically, the tracking loop which results works to complicate rather than to simplify the textual organisation.

6.25 Experiential Meaning

6.251 General Lexicogrammatical Patterns, IDEATION and Experiential Metaphor

The frequency of each process type is summarised in Table 6.33. Relational processes are the most common process realised in Lesson B. Nearly two thirds of the Relational processes are Attributive. More delicately, Intensive processes are realised most often especially with respect to the Relational Identifying processes. Material processes also feature as most common process if Attributive and Identifying Relational processes are considered as separate categories. Given the field structured nature of the discourse, this is not surprising. Compared with Lesson A, there are proportionally less Mental processes in Lesson B. Within the category of Mental processes, however, processes of Affect are relatively more common in Lesson B than in Lesson A. This highlights the relative prominence of affect in both lessons.

As found in each lesson, the proportion of rankshifted Operative processes is significantly higher than those found in the ranking clause. In Lesson B, Operative processes account for 42.3% of rankshifted processes.

Table 6.33 TRANSITIVITY: Process selections

	Major Clauses		Rankshifted Clauses		Overall Totals	
	Total	Percentage	Total	Percentage	Total	Percentage
Processes	948	100	149	100	1097	100
MATERIAL	252	26.6	35	23.5	287	26.2
MENTAL	147	15.5	9	6.0	156	14.2
Cognition	93		4			
Perception	23		1			
Affection	31		4			
RELATIONAL - ATTRIBUTIVE	240	25.3	21	14.1	261	23.8
Intensive	137		10			
Circumstantial	23		3			
Possessive	80		8			
RELATIONAL - IDENTIFYING	148	15.6	13	8.7	161	14.7
Intensive	147		13			
Circumstantial	1					
Possessive	0					
OPERATIVE	32	3.4	63	42.3	95	8.7
VERBAL	78	8.2	6	4.0	84	7.7
BEHAVIOURAL	23	2.4	0	0.0	23	2.1
EXISTENTIAL	28	3.0	2	1.3	30	2.7

As displayed in Table 6.34, the Voice of the majority of clauses is 'middle' rather than 'effective'. Given the contrast between the western cultural context in which we live where it is all fast action between participants and a question of gaining material possessions and the experiential meanings realised in the discourse of mathematics, it perhaps comes as no surprise that mathematics is viewed by the majority as external to our inculcated interests.

Table 6.34 Voice

	Ranking Clauses	Percent-age	Rank-shifted	Percent-age	Total	Percent-age
CLASSIFIED CLAUSES	840	100	150	100	990	100
EFFECTIVE	176	21.0	10	6.7	186	18.8
1. Active	171		10			
Agent	163		9			
Ellipsed Agent	8		1			
2. Passive	5		0			
MIDDLE (Active)	567	67.5	119	79.3	686	69.3
Medium	562		119			
Ellipsed Medium	5		0			
3. NO VOICE	97	11.5	21	14.0	118	11.9

Although comparable to Lessons C1 and C2, there is a lower incidence of metaphorical processes in Lesson B compared with Lesson A. As may be seen in Table 6.35, with minor exceptions these processes are either Mental or Operative.

Table 6.35 Metaphorical processes

	Major Clauses		Rankshifted Clauses		Overall Totals	
	Total	Percentage	Total	Percentage	Total	Percentage
Processes	12	100	9	100	21	100
MENTAL	8	66.7	2	20.2	10	47.6
Cognition	8		2			
Perception						
Affection						
OPERATIVE	3	25.0	7	77.7	11	52.4
VERBAL	1	8.3			1	4.8

Metaphorical Operative processes may be realised through semiotic metaphor as previously discussed in section 5.251 in Chapter 5. These arise as the result of the lexicogrammar of mathematical symbolism whereby spatial position has a meaning potential not found in language. This results in linguistic prepositional phrases such as "over" and "on" realising the process of division.

Table 6.36 Examples of metaphorical Operative processes

Clause N°/ Speaker	Rank	Process	Participants
121 Er	(2a)	over	X1= [[[[minus 'b' plus or minus [[the square root of [[[['b' squared]] minus four 'ac']]]]]]
173 T	(3a)	on	X1= [[the minus 'b' X2= the two 'a']]
372 T	(2a)	over	X1= [[[[minus one plus or minus the square root of twenty five]]
373 T	(2a)	on	X1= [[[[minus one plus or minus five]] X2= four]]
380 T	(2a)	over	X1= [[four X2= four]]
386 T	(1a)	[on	X2= four]
387 T	(2a)	[on	X1= negative six X2= four]]
480 T	(1a)	[over	X1= six]
1081 T	(2a)	and	X1= [[negative 'x' X2= negative 'x']]
1084 T	(1a)	put	X1= the twenty

Another form of semiotic metaphor resulting from the shift in codes from mathematical symbolism to language occurs in Lesson B. For example, the mathematical symbolic expression

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

becomes "minus b plus or minus the square root of b squared minus four ac over two a" (clause 121) when verbalised. This may function as a rankshifted participant in a ranking clause as illustrated by:

> x equals [[minus b plus or minus the square root of b squared minus four ac over two a]].

The nuclear configuration of the verbalised clausal rankshifted participant is ambiguous. Due to the systems constituting the lexicogrammar of mathematical symbolism, there exists no such ambiguity in the symbolic statement. However, the lexicogrammatical systems for organising experiential meaning in language are different from those operating in the symbolism and as a consequence ambiguity is introduced. However, if "over" is correctly taken as the next ranking process which metaphorically realises division, the two participants are "[[minus b plus or minus the square root of b squared minus four ac]]" and "two a". The nuclear configuration of this rankshifted clausal participant is also ambiguous for

the reasons given above. If once again the process "plus or minus" is correctly identified as the next ranking process, then the participants are "minus b" and "the square root of b squared minus four ac". It is this rankshifted participant that I shall now analyse in terms of semiotic metaphor.

the	square	root	of	[[b	squared]]	minus	four	ac]]
Deictic	Classifier	Thing	Qualifier					
				Participant		Process	Participant	

Figure 6.12 The experiential structure of the nominal group

As seen in Figure 6.12, "the square root of b squared minus four ac" is a nominal group with a rankshifted clausal Qualifier. This means that the "$\sqrt{\ }$" in mathematical symbolism is realised as a participant in the form of a rankshifted nominal group in language. I argue that a process has become a participant in the shift from mathematical symbolism to language. That "$\sqrt{\ }$" functions as a process in mathematical symbolism can be demonstrated through the verbalisation of an equivalent symbolic statement.

Firstly, "$\sqrt{b^2 - 4ac}$" is equivalent to "$(b^2 - 4ac)^{\frac{1}{2}}$". Secondly, if this is verbalised, one such expression may be "[[b squared minus four ac]] raised to the power of one half". Thirdly, ignoring the ambiguity that inevitably arises in this verbalisation, the linguistic translation "raised to" realises a process. More simply put, this means that "the square root of" is congruently realised as "raised to the power of one half". This means that "the square root of" is an example of semiotic metaphor whereby a process in the mathematical symbolism is changed to a participant in language. This phenomenon is further explored in section 6.253 which deals with the experiential meaning of the symbolic text.

Examples of grammatical metaphor which realise experiential meaning are listed in Table 6.37 below. They serve to illustrate several features of this mechanism. Firstly, grammatical metaphor functions to describe everyday reality as seen in the first two examples of Lesson B with "attention" (clause 3) and "congratulations" (clause 13) . It is not only a feature of mathematical

and scientific reality, but also functions to construct everyday reality. In the first example, it is also tied to interpersonal metaphor. Rather than congruently realising the imperative command "attend" or rather "listen", the command is expressed as a polar interrogative with "attention" as the entity in question. Secondly, the examples of "discriminant" (clause 194), "solution" (clause 212) and "approximation" (clause 467) are mathematical register items. Through the meaning potential of the semiotic of mathematical symbolism these 'Things' have come to exist. As the metadiscourse for mathematical symbolism language has adapted to include these extensions of meaning potential through grammatical metaphor.

Table 6.37 Grammatical metaphor and experiential meaning

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause: **LOGICAL (internal relations)** **EXPERIENTIAL and** **INTERPERSONAL**	
process ——> attend congratulate equate discriminate discriminate solve approximate	**entity** 'Thing' in nominal group 3 T // alright girls can I just have your **attention** please 13 T // **congratulations** [to all the rowers [[that did win]]] 72 T // [[what we are trying to do here]] is [[to solve **equations**] 194 T // this thing is called the **discriminant** 203 Er // **discrimination** 212 Er // **the number of solutions** 467 T // then do **an approximation** [at the end] [to a couple of decimal places]
process ----->	**quality**
a function which solves equations	Modifier in nominal group 521 T // but this particular one has <um> **solving equations functions**

In the last example in Table 6.37, the grammatical metaphor involves a shift whereby a process is expressed as a Modifier in a nominal group. As may be seen from the congruent realisation, the effect of the grammatical metaphor

is the elimination of the rankshifted clausal element in the congruent expression. The potential for this option still exists, however, in the metaphorical expression. If realised, and even as it stands, this means the metaphorical expression has more densely packed experiential meaning than the congruent expression. This is one function of grammatical metaphor. Not only are entities created that may be related to other entities, but also the potential to increase the density of experiential meaning is realised.

The classifications of mathematical register items realised in Lesson B are summarised in Table 6.38 below.

Table 6.38 Classification of mathematical register items

	Total	Percentage (1 d.p.)
CLASSIFICATION	586	100
Technical	425	72.5
Jargon	13	2.2
Non-technical	148	25.3
ELEMENTS	619*	100
Clausal	58	9.4
Nominal Group	393	63.5
Thing	387	
ellipsed Thing	5	
Deictic	193	
Epithet	22	
Numerative	43	
Classifier	69	
Qualifier	39	
Verbal Group	75	12.1
	65	
Event	65	
Finite	15	
Polarity		
Auxiliary	1	
Phrase	10	
Event	10	
Finite	3	
Polarity		
Auxiliary		
Prepositional Group	57	9.2
Phrase	56	
Adverbial	22	3.6
Attribute	14	2.4

Comparisons with the other lessons reveal that Lesson B is positioned between Lesson A and Lessons C1 and C2 in terms of the incidence of technical terms versus non-technical terms. The highest proportion of technical register specific items is found in Lesson A and the lowest in Lessons C1 and C2. These differences are significant with the proportion of technical terms being 82.5%, 72.5%, 63.7% and 51.6% in Lesson A, Lesson B, Lesson C2 and Lesson C1 respectively. This reflects the relative positioning of the lessons in terms of the formal discourse of mathematics. The incidence of jargon terms is lowest in Lesson B and highest in Lesson C1.

The majority of mathematics register items in Lesson B are realised as nominal groups. This trend is found in all lessons with approximately sixty percent of all mathematical items being expressed as nominal groups. The components of the nominal group which occur most often are Deictics although in total there are less than fifty percent of these items compared to the total number of nominal groups in Lesson B. Relatively speaking, there are more Classifiers and fewer Qualifiers realised in Lesson B compared with Lesson A. As Qualifiers tend to be rankshifted phrases or clauses, this indicates that mathematical lexical items in Lesson A are generally more densely packed with respect to experiential meaning than those found in Lesson B. Further to this, a similar though lower incidence of Qualifiers in Lesson C2 points to the field of the mathematical discourse as affecting the structure of the nominal group. In both Lessons A and C2, the field is trigonometry where nominal groups with Qualifiers such as the "tangent of theta" and the "sine of A" are commonly realised. On the other hand, the field of Lessons B and C1 is algebra where the packing of experiential content is largely realised through clausal rankshift. In both Lessons B and C1, Classifiers form part of the structure of the nominal group more often than Qualifiers. Nevertheless this does not mean that complex nominal groups do not occur in Lesson B. The example below is a classic in terms of packing experiential content into one lexical item.

797 T // the sum [of the squares [of two consecutive positive even integers]]

The experiential structure of this nominal group together with its translation into mathematical symbolism is discussed in detail in section 6.253, "The Mathematical Text"

The highest incidence of register items which pertain to some other field is found in Lesson B. These items are summarised in Table 6.39 below. These are mostly educational jargon terms such as "lay your pens down" (clause 64), "eyes this way" (clause 65), "hands up" (clause 93) and "I was away" (clause 106). The teacher also digresses from the mathematical content of the lesson to talk about calculators and upper school courses.

Table 6.39 Other register items

	Total
REGISTER ITEMS	53
Educational • technical • jargon • non-technical	50 5 45
Officialese	0
X-ese	
Academic	1
Youth Culture	1
Other	1

The cohesion of the oral discourse is dependent upon the visual symbolic text and the lexical relations realised therein. As a feature of mathematical discourse, taxonomic relations play a major role in text cohesion. Before we investigate these patterns, it is worth noting that expectancy relations play a major role in lexical relations in Lesson B. The quadratic formula with its conventionalised participants of "a", "b" and "c" and the associated nuclear configurations are expected as the means to solution of the quadratic equations given the review nature of Lesson B. The nature of the discriminant as determining the differing number of solutions for quadratic equation is also expected. These expectancy relations perhaps play a less significant role when the word problems are attempted towards the end of the lesson.

A non-exhaustive taxonomy of major participants and processes for the oral and visual discourse is given in Table 6.40. As seen, the lexical relations stretch across semiotic codes to create interwoven patterns. The majority of lexical relations involve classification as found in the type of equation, the quadratic formula as one method of solution, the number of solutions and its relations with the value of the discriminant. Compositional relations are realised in connection with the parts of quadratic formula such as the

'discriminant' and the components of the quadratic equation such as the 'coefficient'. As for all mathematical discourse, taxonomic relations function as a crucial component in realising experiential meaning.

Table 6.40 Taxonomic relations of major participants and processes

Field	Oral linguistic text	Symbolic Text
Equations	• equations	
1. Quadratic equations (subclass of class: equations)	• quadratic equation	• $2c^2 + c - 3 = 0$ • $4y^2 - 6y + 3 = 0$ • $\frac{3}{2}m^2 - \frac{1}{5}m - 1 = 0$ • $a^2 + (a+2)^2 = 340$ • $a^2 + a^2 + 4a + 4 = 340$ • $2a^2 + 4a - 336 = 0$ (co-hyponymy)
2. Terms of quadratic expression (meronymy)	• variable • letter • coefficient (co-meronymy)	For example • c, y, m, a, b, c • c, y, m, a, b, c • 2, 1, -3 (co-hyponymy)
3. Solution of quadratic equations (* Expectancy relation)	• solve	• solve
a. the quadratic formula (subclass of methods available for solution of quadratic equations)	• the quadratic formula • [[[[minus 'b' plus or minus [[the square root of [[[['b' squared]] minus four 'ac']]]]]] over two 'a']] (synonymy) • [[[[minus one plus or minus the square root of twenty five]] over [[two twos are four]]]]	$c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
i. Parts of the quadratic formula (meronymy)	• discriminant • the thing [under the square root sign]]] (synonymy) • the square root	• Discriminant ($b^2 - 4ac$) • $b^2 - 4ac$

ii. the solution	• the number of solutions • no solution, one solution, two solutions • the answer (synonymy)	① Number of Solutions 1 Solution if $(b^2 - 4ac) = 0$ ② 2 Solutions if $(b^2 - 4ac) > 0$ ③ No Solutions if $(b^2 - 4ac) < 0$
4. Arithmetic Operations (subclass of class Operative Processes)	• add, adding, the sum (synonymy) • taking, minus (synonymy) • plus or minus • multiply • over, on (synonymy) • squared • the square root	• + • - • (indicated by brackets or implicit) • (indicated by fraction line) • for example, b^2 • $\sqrt{b^2 - 4ac}$

The nuclear relations realised in nuclear configurations are generally not as complex as those found in Lesson A. In combination with the simplification made possible through numerical participants, the teacher progresses slowly through the solution to the quadratic equations using the quadratic formula and the solution of the word problems. This results in nuclear configurations in the oral discourse that do not have the same degree of rankshift as Lesson A although exceptions do occur, especially in the case of the quadratic formula.

For illustration purposes, an excerpt from Lesson B is given in Table 6.41. This includes statement of the quadratic formula as one case of multiple clausal rankshift.

Table 6.41 Nuclear relations

Clause		Centre	Nucleus	Margin	Periphery
		PROCESS = Range: process	+Medium +Range: entity	+Agent +Beneficiary	x Circumstance
119 T	// could somebody read the quadratic formula [off their ah/ maths aids [for me]] please	read	•somebody • the quadratic formula	•for me	off their maths aids
120 T	// OK Erica				
121 Er	/// ah/ [[[[minus 'b' plus or minus [[the square root of [[[['b' squared]] minus four 'ac']]]]]] over two 'a']]		•[[[[minus 'b' plus or minus [[the square root of [[[['b' squared]] minus four 'ac']]]]]] over two 'a']]		
	#A4 Solve $2c^2 + c - 3 = 0$ $= 0$ $c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$		$c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$		
122 T	// OK as I said	•said	•I		
123 T	// that looks complicated doesn't it	•looks •complicated	• that		
124 T	// but [[all you need to do]] is [[copy it [off your um/ math aid]]]	•is	•copy it off your math aid	•all you need to do	
125 T	// now unfortunately I 've got a bit of a mix up here [in symbols]	• have	•I •a mixup [in symbols}		
126 T	// by calling them variables	•calling	•them •variables		
127 T	// the 'c' and this 'c' aren't the same	•are not • the same'	•the 'c' and this 'c		

	## teacher indicates the two sets of variables				
128 T	// who can tell me	•tell	•who	•me	
129 T	// what the 'a' is	•is	•what	•'a'	
130 T	// hands up	•(put)	•hands •up	•(you)	
131 T	// if you can tell me the 'a'	•tell	•you	•me	
132 T	// Karen				
133 T	/// ah/ the two [in front of the [['c' squared]]]		•the two		•[in front of the [['c' squared]]]
134 T	// OK what 's 'b'	•is	•what	•'b'	
135 T	/// ah/ the plus one		•the plus one		
136T	// which is there	•is	•which •there		
137 T	// yeah				
138 T	// and the negative three is the 'c'	•is	•'c'	•the negative three	
	#A5 Solve $2c^2 + c - 3 = 0$ a b c $c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$		Solve $2c^2 + c - 3 = 0$ a b c =2 =1 =-3		

6.252 Field

The range of field selections is evident from the range of microgenres which constitute Lesson B. Surges of interpersonal meaning as found in Student Interruptions and Teacher Disciplinary Interruptions in combination with teacher digressions evidenced in Teacher Exposition means that at times the Field selections move away from the course content of the algebraic solution of quadratic equations. The Teacher Exposition nevertheless serves two important functions. Firstly, the Year Ten mathematical results are

contextualised with respect to the new content presented in Year Twelve, and secondly, the pen and paper method of solution is contrasted to that available using the latest calculator technology. This same level of contextualisation of the field of the course content does not occur in any of the other lessons.

In the Homework Discussion, the Student Review Task Discussion and the Board Demonstration microgenres, the pacing tends to be much slower than found in Lesson A. The teacher proceeds carefully and frequently stops to ensure that the students have coped with the work. This results in multiple Diagnostic Activity microgenres. Despite this, experiential meaning does not tend to dominate the whole of Lesson B. As evident from the range of microgenres, the interruptions and the private interactions, the students are engaged in other activities apart from learning mathematical discourse.

6.253 The Mathematical Text

The experiential meaning of the symbolic text is examined through analysis of the nuclear configurations at the discourse semantics stratum. An analysis of an excerpt from Lesson B is given in Table 6.42 below. What is immediately apparent is the narrow range of processes, the multiple levels of rankshift and the lack of a 'Periphery' realising Circumstance.

The processes are either Relational Intensive Identifying processes realised by " = " or Operative processes realised by "+", "- ", "x" , "± ", "$\sqrt{\ }$ " with division realised by spatial position and the fraction line. With the arithmetic Operative processes, condensation occurs with the Operative processes of addition and subtraction combined into symbol "±". The square root is an Operative process and as such is a case of semiotic metaphor when verbalised as previously discussed in section 6.251.

The multiple levels of rankshift are evident in Table 6.42 where the deepest level is 'Rank 6'. The grammar of mathematical symbolism functions to condense and compact experiential meaning through clausal rankshift while at the same time dispensing with peripheral information where possible. As seen below, the algebraic derivation of the solution of the quadratic equation consists of a Centre, Nucleus and Margin only. This lack of peripheral information contributes to the view of mathematics as universal truth

Table 6.42 Nuclear relations in the symbolic text

	Clause	Centre PROCESS = Range: process	Nucleus + Medium + Range: entity	Margin + Agent + Beneficiary
1.	**Solve** $[[[[2[[c^{2}]] + c]] - 3]] = 0$ a = 2 b = 1 c = -3			
	Rank 1a (i)	=	• 2	• a
	Rank 1a (ii)	=	• 1	• b
	Rank 1a (iii)	=	• c • -3	
	Rank 1b	=	• 0	• $[[[[2[[c^2]]+ c]]- 3]]$
	Rank 2	-	• $[[2[[c^2]]+ c]]$ • 3	
	Rank 3	+	• $[[2[[c^2]]$ • c	
	Rank 4	x	• c • c	
2.	$c = \left[\left[\frac{[[-b \pm [[\sqrt{[[[[b^2]] - 4[[ac]]]]}]]]]}{2a}\right]\right]$			
	Rank 1	=	• $\left[\left[\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\right]\right]$	• c
	Rank 2	÷	• $[[-b \pm \sqrt{b^2 - 4ac}]]$ • 2a	
	Rank 3	±	• $\sqrt{b^2 - 4ac}$ • -b	
	Rank 4	$\sqrt{}$	• $b^2 - 4ac$	
	Rank 5	-	• b^2 • 4ac	
	Rank 6 (i)	x	• b • b	
	Rank 6 (ii)	x	• a • c	
3.	$[[([[b^2]]- 4[[ac]])]]$			

	Rank 1	-	• b^2 • 4ac	
	Rank 2 (i)	x	• b • b	
	Rank 2 (ii)	x	• a • c	
4.	**= [[1 - [[4.2. (-3)]]]]**			
	Rank 1	=	• 1 - 4.2. (-3)	
	Rank 2	-	• 1 • 4.2. (-3)	
	Rank 3	x	• 4 • 2 • (-3)	
5.	**= [[1 + 24]]**			
	Rank 1	=	• 1 + 24	
	Rank 2	+	• 1 • 24	
6.	**=25**			
	Rank 1	=	• 25	
7.	$c = \left[\left[\frac{[[-1 \pm [[\sqrt{25}]]]]}{4} \right]\right]$			
	Rank 1	=	• $\left[\left[\frac{[[-1 \pm [[\sqrt{25}]]]]}{4} \right]\right]$	•c
	Rank 2	÷	• [[-1 ± [[$\sqrt{25}$]]]] • 4	
	Rank 3	±	• -1 • $\sqrt{25}$	
	Rank 4	$\sqrt{}$	• 25	
8.	$= \left[\left[\frac{[[-1 \pm 5]]}{4} \right]\right]$			
	Rank 1	=	• $\left[\left[\frac{[[-1 \pm 5]]}{4} \right]\right]$	
	Rank 2	÷	• [[-1 ± 5]] • 4	
	Rank 3	±	• -1 • 5	
9.	$c = 1$ or $c = \frac{-6}{4}$ or - 1.5			
	Rank 1 (i)	=	• 1	• c
	Rank 1 (ii)	=	• $\frac{-6}{4}$ • -1.5	• c

when in fact its 'truth' is contextually dependent on the system within which it is constructed.

One other dimension of experiential meaning that deserves attention is the shift from written linguistic problems and their translation into mathematical symbolism. One of the word problems that the students attempt from the mathematical textbook in Lesson B is given below.

> The sum of the squares of two consecutive positive even integers is 340. What are they?

The experiential structure of the first nominal group is given below in Figure 6.13. As may be seen, there are two levels of phrasal rankshift with the experiential structure of the most deeply embedded or 'kernel' nominal group consisting of a Numerative, a Epithet, two Classifiers and a Thing.

the	sum	of	the	squar -es	of	two	consec- utive	positi ve	even	integers
Deictic	Thing	Qualifier								
			Deictic	Thing	Qualifier					
						Numer -ative	Epith- et	Class- ifier	Class- ifier	Thing

Figure 6.13 The experiential structure of the nominal group

The teacher writes the following symbolic statement for this problem.

$$a^2 + (a + 2)^2 = 340$$

The rankshifted clausal participants in this mathematical statement which involves a Relational Intensive Identifying process in the ranking clause are indicated below.

$$[[[[a^2]] + [[[[(a + 2)]]^2]]]] = 340$$

Several features of the experiential meaning of both the linguistic and symbolic texts become apparent. Firstly, as indicated in Figure 6.13, experiential meaning is densely packed into the nominal group "the sum of

the squares of two consecutive positive even integers". In the translation to symbolic text, it may be seen that this is a case of semiotic metaphor whereby the Things "the sum" and "the squares" congruently realise the Operative processes of adding and squaring. The "consecutive" and "even" intersect experientially to give two numbers which differ by two. This results in "a+2" which is a clausal rankshifted participant in the symbolic text. It appears that in language, the strategy for packing experiential meaning is realised through nominal group structures while in mathematical symbolism, an alternative strategy involves clausal rankshift of nuclear configurations involving Operative processes. The bridge between these two strategies is semiotic metaphor.

The difficulties of firstly unpacking the experiential meaning of the linguistic text and secondly translating this into mathematical symbolism are respectively recognised by the teacher in his tagged declarative "that's a mouthful isn't it" (clause 823) and the careful development of the symbolic statement which is realised in clauses 817 to 897.

This analysis as yet only touches upon the strategies through which experiential meaning is constructed in visual texts consisting of the semiotic codes of language and mathematical symbolism and the subsequent nature of semiotic metaphor occurring in shifts between the two codes. As for many other dimensions of this study, further analysis is required.

6.26 Logical Meaning

6.261 General Lexicogrammatical Patterns, CONJUNCTION & CONTINUITY and Logical Metaphor

The classification of the logico-semantic relations realised in Lesson B are summarised in Table 6.43. As for each lesson analysed in this study, the majority of clause complex relations involve EXPANSION. While Lesson A leads the field in terms of the density of these relations, Lessons B, C1 and C2 are similarly placed in terms of the incidence of the types of logico-semantic relations with Lesson B realising slightly more relations of EXPANSION.

Table 6.43 Logico-semantic relations

NATURE OF RELATION	Total	Percentage (1 d.p.)
	1064	100
Expansion	376	35.3
Projection	91	8.6
No relation	597	56.1

As seen in Table 6.44, in Lesson B student clauses realise only 6.6% of the total number of clause complex relations involving EXPANSION and 2.2% of relations involving PROJECTION. Student contributions are also uniformly low in Lesson C1 and C2 compared with Lesson A. This indicates that students in Lesson A more frequently construct logical relations than students in any of the other lessons.

Table 6.44 Logico-semantic relations: Teacher and student contributions

NATURE OF RELATION	Total	Percentage (1 d.p.)
Expansion (n = 376)		
Teacher	351	93.4
Students	25	6.6
Projection (n = 91)		
Teacher	89	97.8
Students	2	2.2

The relative proportion of relations of PROJECTION involving Locution and Idea are equivalent to those found in Lesson A. The incidence of these relations are displayed in Table 6.45 below. In Lesson C1 and C2 however, fewer relations involving Locution are realised. This phenomenon is most marked in Lesson C1 where only two such relations are realised in the entire lesson. Nevertheless, across all lessons selections from the system of PROJECTION are more frequently directed towards 'thinking' as opposed to 'saying'.

Table 6.45 Interdependency and PROJECTION

PROJECTION	n = 91	
	Paratactic	Hypotactic
	0	100% (91)
Idea	0	72.5% (66)
Locution	0	27.5% (25)

The nature of the clause complex relations involving EXPANSION are summarised below in Table 6.46. The dominant type of interdependency between clauses is individually paratactic and Enhancement. Although this trend extends to all lessons, in Lessons A and B these intersect to form a major category while in Lessons C1 and C2 the most prevalent category is hypotactic Enhancement and paratactic Extension relations respectively. If the few student clauses of Lesson B are considered separately as displayed in Table 6.47, the relations are more evenly spread as hypotactic and paratactic. Once again, Enhancement dominates with the major category being hypotactic Enhancement. It appears that in mathematical pedagogical discourse, the secondary clause functions to expand on the meaning of the primary clause. As for Lesson A, paratactic relations of Extension are also frequent, indicating the field structured nature of relations.

As displayed in Table 6.46, the majority of logical relations are external indicating an orientation towards experiential meaning. This orientation is most marked in Lesson B with the lowest number of internal relations being realised out of the four lessons. It appears that the oral discourse is not orientated towards constructing rhetorical arguments. This position does not resonate with the symbolic mathematical text of Lesson B where the logical organisation is exclusively internal.

The nature of the categories of logical relations in Lesson B is similar to those found in Lesson A. That is, Consequential relations dominate with the major category being paratactic relations of 'Consequential: consequence'. This relation is most commonly realised by the Conjunction "so". In Lesson B, hypotactic 'Consequential: condition' realised by "if"

Table 6.46 Interdependency and EXPANSION

EXPANSION	n = 376											
	Cohesive 2.4% (9)				**Paratactic** 59.8% (225)				**Hypotactic** 37.8% (142)			
Elaboration 7.2% (27)	1.1% (4)				1.9% (7)				4.3% (16)			
Extension 24.5% (92)	0.8% (3)				22.9% (86)				0.8% (3)			
Enhancement 68.4% (257)	0.5% (2)				35.1% (132)				32.7% (123)			
External (355) **Internal** (21)	Internal 6		External 3		Internal 9		External 216		Internal 6		External 136	
Explicit (320) **Implicit** (56)	Ex 3	Im 3	Ex 3	Im 0	Ex 1	Im 8	Ex 199	Im 17	Ex 6	Im 0	Ex 108	Im 28
Elucidative (27)												
opposition (16)	1	1				7			3		3	1
clarification (11)	1	1							1		6	2
Addition (80)												
addition (63)					1	1	55	6				
alternation (17)			3				13	1				
Comparative (12)												
similarity (2)									1		1	
contrast (10)							8	1	1			
Temporal (38)												
simultaneous (14)											14	
successive (24)							20				4	
Consequential (219)												
purpose (8)												8
condition (74)							10				61	3
consequence (124)							85	8			17	14
concession (12)	1	1					8	1			1	
manner (1)											1	

Table 6.47 Interdependency and EXPANSION: Student contributions

EXPANSION	n = 25		
	Cohesive	**Paratactic**	**Hypotactic**
	4.0% (1)	44.0% (11)	52.0% (13)
Elaboration 12.0% (3)	0% (0)	4.0% (1)	2.0% (2)
Extension 32.0% (8)	4.0% (1)	28.0% (7)	0% (0)
Enhancement 56.0% (14)	0% (0)	12.0% (3)	44.0% (11)

follows in terms of frequency, while in Lesson A, Additive: addition relations are the next common category. This may be explained by the differing fields of discourse. Lesson A deals with the trigonometric solution of an everyday problem and initially the logical relations are orientated more towards experiential meaning. In Lesson B, however, the field is the algebraic solution to quadratic equations. The logical relations are thus similar to those found generically in mathematical symbolic texts. It is surprising that internal relations are not realised more often in Lesson B. Despite the fields of algebra and trigonometry respectively in Lessons C1 and C2, 'Additive' relations are foregrounded. The logical relations in these lessons therefore do not reverberate with those found in mathematical reasoning.

Multiple selections from the system of CONTINUITY function in Lesson B to realise logical progression. These selections include expressions such as "OK", "well" and "right". These feature in each of the lessons and seem to be a constituent of pedagogical discourse. In Lesson B, however, there are one hundred and twenty three clauses with one Continuative and seven clauses with two Continuatives. This gives a total of one hundred and thirty seven Continuatives per one thousand and sixty seven clauses. In other words, on average 6.6% of the clauses contain a Continuative. This is the lowest frequency in any of the four lessons with a marked difference being the high frequency of Continuatives realised in Lesson A. This tends to

indicate that the oral discourse of Lesson B does not cohere in a progressive sense to the same degree as other lessons, especially when compared with Lesson A. The disjointed nature of Lesson B and its dependency on contextual parameters contributes to this overall lack of continuity.

Logical meaning tends to be congruently realised in Lesson B. Logical relations are realised by Conjunctive Adjuncts and Conjunctions. Two examples of metaphorical realisations are given below in Table 6.48. The 'Consequential: consequence' relation congruently realised by "so" is realised by the process "means". This example of grammatical metaphor is also found in Lesson A.

Table 6.48 Grammatical metaphor and logical relations

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause complex: LOGICAL	
relator —>	**process**
so	312 T // like that **means** a negative number 590 T // which **means** [[that we will be able to do this very quickly]]

6.262 Mathematical Reasoning

Given the relatively low incidence of logical relations as compared with Lesson A, it appears that the implication chains realising mathematical reasoning do not occur to the same extent as in Lesson B. Nevertheless, the basis for making logical relations remains unchanged. The ubiquitous "so", "if" and "because" indicate that the logical connections are a consequence of some predetermined condition. As previously seen in section 5.264, these conditions are dependent on mathematical properties, axioms, definitions and results.

6.263 The Mathematical Text

The conjunctive reticula of the logical relations found in the symbolic board text in Lesson B is given below in Figure 6.14. It is obvious that the teacher's

strategy of spatially compartmentalising parts of the text serves to complicate the chains of logical reasoning. The logical internal relations point directly upwards in generic texts. In Figure 6.14, however, we may see that circular loops are created as a result of calculating the value of the discriminant on the right hand side of the board text. Though intended to 'simplify' the calculations, the opposite effect in terms of tracing the logical progression of the problem is achieved.

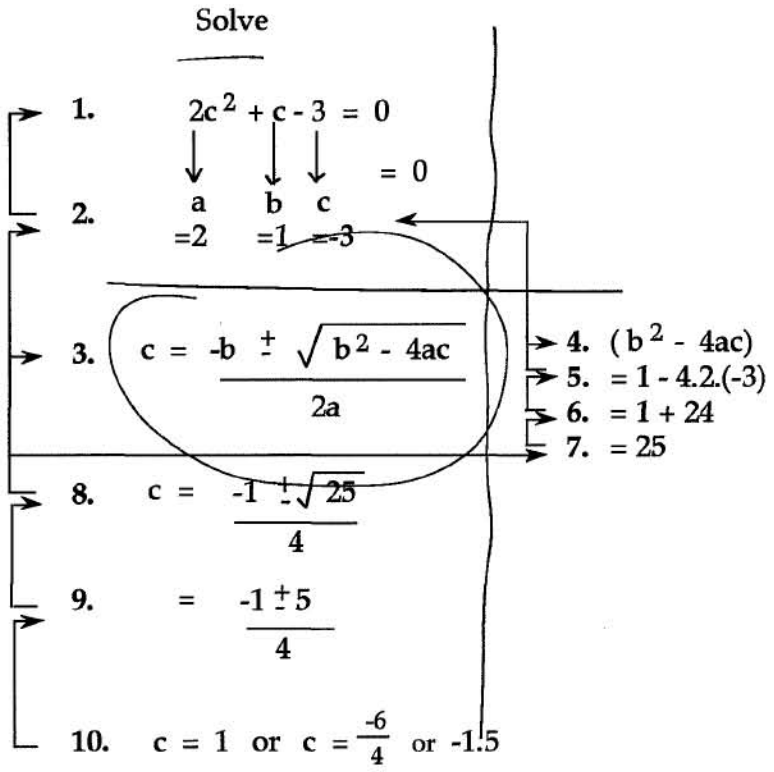


Figure 6.14 Logical relations in the symbolic text

The mathematical definitions and results on which the logical chains of reasoning are constructed are listed below per line of text.

2. Convention
The standard form of a quadratic equation is
$ax^2 \pm bx \pm c = 0$
where "a", "b" and "c" are the variables respectively for coefficients of each term

3. Mathematical Result
The quadratic formula derived algebraically as the solution to the standard form of the quadratic equation

5. a. Substitution involving Equality Properties
b. Rule of Order

6. a. Rule of Order
   b. Property (negative numbers)
   c. Definition (of subtraction)

7. Rule of Order

8. a. Substitution
   b. Properties (negative number)

9. a. Rule of Order
   b. Definition (Square Root)

10. a. Rule of Order
    b. Definition (subtraction)
    c. Properties (negative numbers)

Once again, the conditions and consequential basis for the rhetorical argument realised in the board text in Lesson B are based on fundamental mathematical properties, definitions and rules which are not explicitly realised in the symbolic text. Students do not seem to experience difficulty, possibly due to the aid of calculators.

The logic realised in the board text given in Figure 6.15 is of some interest. As explicitly stated, the number of solutions is dependent on the value of the discriminant as being zero, positive or negative. However, this logic only extends to the real number system, since the square root of a negative number does not exist in this system. As the teacher rightly points out, these

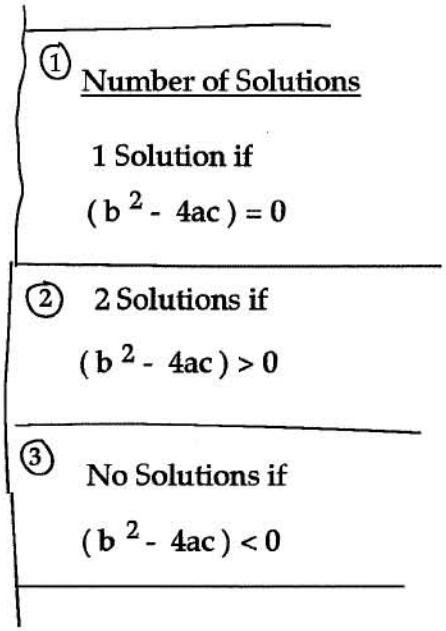


Figure 6.15 Logical relations in the symbolic text

results do not hold for complex number system, as the square root of negative one is defined. This highlights the limited sphere of the conditions for mathematical reasoning which often are not made explicit. The logical basis for mathematical arguments is not explained as relative to the mathematical system in which it is constructed. Mathematical truths and mathematical reasoning are seen to have universal applicability and truth when in fact their 'truth' is only relative to the mathematical systems in which they are constructed. One other simple example is the case of non-Euclidean geometry where no longer is the sum of the angles of a triangle equal to one hundred and eighty degrees. The distorted view of mathematics as universal truth is revisited in Chapter 9.

6.3 The Texture and Ideology of Lesson B

As for each chapter, given the constraints of the study, detailed analyses of the interactions across strata are not completed. With respect to the method of development of Lesson B, the patterns are somewhat more complicated given the multiple microgenres that constitute Lesson B. In the Homework Discussion, the 'Stack' is realised by macro-Theme of reviewing the homework.

38 T // we 've got to go over the homework quickly
51 T // we 'll just go over <<say>> one or two [for everybody's benefit]

This is followed by Hypo-Themes related to each of the problems which are reviewed and completed in the Student Review Task. Within each of these segments, the 'Step' is realised as set activity sequences such as copying down the problem, watching the board and copying the solution or alternatively, attempting the problem and correcting the answers. Within each 'Step', more delicate 'Steps' are realised. This is yet another dimension in which Lesson B varies from Lesson A. There is not the same sense of 'balance' in Lesson B where possible alternative avenues are explored. On the contrary, the development of the solution to the problem is completed in definite predetermined stages. However, the differing fields and nature of each lesson must be taken into account. Lesson A perhaps lent itself to an exploratory method of development to a greater degree than Lesson B.

In Lesson B, the end of the revision of the homework is explicit with the following teacher comment.

777 T // alright we must move on now

The Seatwork microgenre involving the revision of the word problems turns into a Board Demonstration microgenre. Given the difficulty that the students experience with the problem, the teacher demonstrates the solution on the board. The 'Stack' structure is thus disrupted and turns into the 'Step' in the board demonstration of the problem. With respect to the solution to the word problem, what is strikingly different about Lesson B with respect to Lesson A is once again the lack of poise and counterpoise which is found in the 'Balance'. In the 'Stack', the lesson continues to progress in a Step like fashion in Lesson B. In addition, the thematic strategies for development show little variation. Calls to known mathematical results illuminate the basis for the stages in the development of the experiential and logical meaning.

The texture of Lesson B is more loosely knit and fluid than Lesson A. While the fibres maintain a thickness that is typical of mathematical discourse, the splitting and cojoining of chains and strings is not as dense as found in Lesson A given the careful steplike development of the mathematical content. The surges of interpersonal meaning mean that gaps necessarily appear in the weave of the fabric. Further to this, the interwoven patterns do not show as much variation as Lesson A as they are constructed through linguistic and mathematical symbolic semiotic codes with visual cues functioning largely for interpersonal meaning.

Apart from the visual texts and the slower pace, what is most strikingly different about Lesson B is the differing nature and subsequent prominence of the tenor relations. Overtly, unequal power relations are realised between the teacher and the students as evident from their respective speech roles in the exchange structure. However, beneath this level, covert patterns of deference collectively function across all dimensions of the foregrounded interpersonal relations.

The teacher and students engage with each other in what could best be called a perfunctory manner. Through the lack of logical connectives and minimal proliferation of Dynamic moves, the exchanges are the shortest found in any lesson. Transitions between microgenres occur frequently in response to contextual factors. Students are often engaged in private interactions and

need to be called upon to pay attention. Although surges of interpersonal meaning are realised in these episodes, the teacher's disciplinary acts realise interpersonal metaphor and a consequent lack of direct interpersonal relations. The teacher's use of the Comment Adjunct "seriously" shows an awareness that the students are consciously playing a game. However, the power that the students are exercising in these episodes in Lesson B is only relative to the context of the classroom. Outside this arena, the patterns do not realise a dominating position given the nature of the register selections. This contrasts sharply with Lesson A where the patterns of dominance extend across field selections of mathematical content. Further to this, the high level of presumption realised in Lesson A is not found in Lesson B. The teacher and students make explicit excuses for not understanding or for not completing the work as illustrated in the following extracts.

50 T // well maybe that 's [[because we rushed it last week]]

105 Em // I don't know
106 Em // I was away
107 T // you were away the whole time were you
108 Em // yes because I was [on that excursion]

804 T* // how are you going Nadine
805 T* // [at the right spot]
806 Nad* // yes
807 Nad* // but I just don't understand it
808 T* // alright well may be if we do one here [up on the screen]
809 T* // it will make a bit more sense then

Non-congruence through interpersonal metaphor is realised between SPEECH FUNCTION and MOOD. Commands, for example are realised through interrogative and declarative MOOD. Ellipsis is common and students respond at times in chorus answers. Although modality and modulation values are high, relatively speaking lower levels of certainly are realised in Lesson B. Affect is realised in Lesson B with surges of interpersonal meaning occurring with amplification. Selections of MOOD TAG, Mood Adjuncts, Comment Adjuncts, colloquial expressions, attitudinal lexis and general lexical items function to promote 'pleasantness', 'politeness' and 'safety'. Anaphoric nouns function euphemistically to cover for mistakes and difficulties. Vocatives function to realise more intimate relations. Overall the interactions smack of

covertness, smugness and a lack of direct relations upon which equality is based.

I have called this chapter "Learning Mathematics and Femininity". The teacher in Lesson B is male and as a consequence of the enrolment rules in School B, the students are female. Given the school fees, these students also come from wealthy families. As the interpersonal patterns realised in the lesson suggest, this does not mean that these students operate from a position of power.

The interpersonal meaning realised in the oral discourse of Lesson B disaccords with the tenor relations realised in mathematical discourse. The students are engaged in practices which foreground interpersonal meaning and realise patterns of deference. Mathematical discourse foregrounds experiential and logical meaning and realises patterns of dominance. This means that the female students in Lesson B are not interpersonally positioned to construct and participate in mathematical discourse. The marginal position of the students resulting from tenor relations is reflected in other dimensions of meaning in Lesson B. Learning mathematics in Lesson B is learning a variation of the genres of mathematics. Technical lexis is not always realised and the density of the chains and strings in the oral discourse is well below that found in the visual texts. With the foregrounding of interpersonal meaning both in the oral and visual texts, experiential and logical meaning is pushed backstage.

In western culture, the world of interpersonal eddies created in Lesson B count for little. Given the valeur accorded to mathematical and scientific knowledge, these students are not only marginalised in relation to the discourse of mathematics, but also to the world despite their wealth and social position. Though not lacking in material comfort, it is quite possible that these students' lives may be impoverished in other directions.

CHAPTER 7

Learning Mathematics and Acquiescence 1

Ben But aren't they supposed to change if they 're negative?
Teacher But there 's no negative there.
Ben Oh. It 's in front of it... the sign. Ahh.
Teacher We all do it mate.

7.1 Contextualisation of School C

The results for School C in the 1995 TEE in Applicable Mathematics, Calculus and Discrete Mathematics are shown below in Figures 7.1, 7.2 and 7.3 respectively. As may be seen, there are very few students in School C who complete TEE mathematics. With the exception of the distribution of Discrete Mathematics scores which is skewed to the left indicating lower than average results, the performance of the few students completing these subjects shows a wide fluctuation. As shown in Table 5.1 in Chapter 5, the average mean score of the students from School C for each mathematics subject is below the state average. One obvious conclusion is that successful participation in the discourse of TEE mathematics is strictly limited in School C.

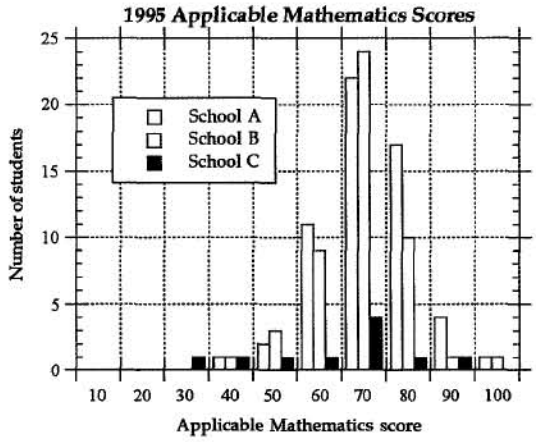


Figure 7.1 Applicable Mathematics

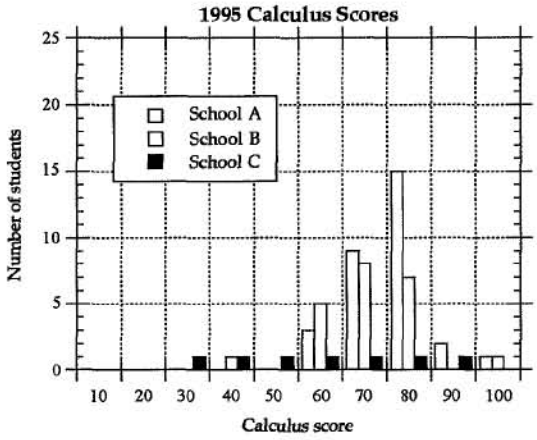


Figure 7.2 Calculus

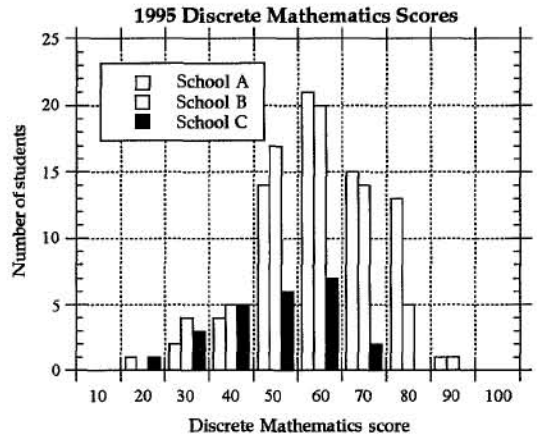


Figure 7.3 Discrete Mathematics

7.2 Lesson C1

The transcript and the stages of the board text for Lesson C1 are given in Table 4(i).1 in Appendix 4(i). Lesson C1 is an elementary algebra lesson which commences with the teacher directing the students to complete the review questions on the board. These problems involve the simplification of algebraic expressions through addition, subtraction and multiplication. A student interrupts to enquire if the homework is to be checked. The teacher proceeds to check the homework by walking around the class while at the same time monitoring student progress on the assigned task. The homework consists of the first fifteen questions from "EXERCISE 2.1"

EXERCISE 2.1

Express the following algebraic expressions in their simplest form.

1. $6a - 3b + 7a - 8b$
2. $4x - 3y - 5z + y + x + z$
3. $7a + 4b + c - 9a - 6b + c$
4. $3r - 4s + 6t - 8r - 5s$
5. $5m - 2n - 3n + 8m - 4n$
6. $-2x + 7y - z - 5y - 3x + 6z$
7. $3a + 5c - 9a + 4b - 2a + 2b$
8. $x - 7y + 6x - z + 5y - 4z$
9. $10d - 9e + 7d - 3f - 5e$
10. $4b - 3a - 9b - 7c - 5a$
11. $3x^2 + 2x - 4 + 5x^2 - 7x$
12. $4ab + 6a - 2b - 3ab + 7a$
13. $9a^2 + 6a - 4 - 5a^2 - 9b + 6$
14. $xy - 3x^2 - 4y^2 + 6xy - 2y^2$
15. $6ab + a^2 + 2b^2 - a + 3a^2 - 2ab$
16. $4m^2 + 9 - 10m - 6m^2 + 3$
17. $6 - 2x - 7x^2 - 12 + 5x^2 + 2x$
18. $10xy - y^2 + 5x^2 - 2xy + y^2 - 8xy$
19. $3a - 7 + 4a^2 - 6a + 3a^2 - 15$
20. $6x^2 - xy - 3x - 2x^2 + 5xy$
21. $2a^2b + 3ab^2 + 4a^2b - 7ab^2$
22. $7x^3 - 3x^2y + 4xy^2 - 3x^3 + 4y^3 - 2x^2y$
23. $a^4 + 3a^2 - 2a - 7a^2 + a^3 + 6a^2$
24. $yz - zx + xy - yz + xy + zx$
25. $2x^3 - x^2 - 3x + 2 - x^3 + x - 1$
26. $15xy^2 - 8x^2y + 10xyz - 4x^2y + 5xyz$
27. $7a^2b + 8ab^2 - b^3 - 5a^2b + 2ab^2$
28. $4b^3 + c^3 - 2abc - a^3 - b^3 - 3abc$
29. $a^3 - 3ab + b^2 - 2a^3 - a^2 + 3b^2 + 5ab$
30. $4x^3 + 3x^2 + x - 4 - 5x^2 - 7x - 11$

REMOVING GROUPING SYMBOLS

Example (i)*:*
Remove parentheses and simplify $(3x + 7) - (2x - 4)$.

Solution:

$$(3x + 7) - (2x - 4) = 3x + 7 - 2x + 4$$
$$= x + 11$$

EXERCISE 2.2

Remove parentheses and simplify:

1. $(5a - 6) + (3a - 4)$
2. $(4x - 5) - (x + 6)$
3. $(7m + 6) - (3m - 5)$
4. $(8 - 3y) - (6 + 6y)$
5. $(9a + 2b) - (3a - 8b)$
6. $(5x - 7y) + (4x - 11y)$
7. $3x - (4x + 6y - 4)$
8. $4a - 2b - (7 + 3b - a)$
9. $5xy - 2x^2 + (3x^2 - 5xy)$
10. $5x^2 + 9 - (2x^2 - 3x - 7)$
11. $2a - (a + 6 - a)$
12. $-x^2 + (7x^2 - 3x + 6)$
13. $6ab - (2ab + 3a - 2b - 7ab)$
14. $4x^2 - (-5x^2) - (3x^2 + 6)$
15. $4a - (a + b) - (a - b)$
16. $7 - (x + 2) + (3 - 2x)$
17. $2a - c - (7c + 21a) - (20a + 8c)$
18. $b + a - c - (c - a - b)$

EXERCISE 2.3

1. Add $5x - y + 4$ to $2x - 3y - 5$.
2. Subtract $4x + y - 5$ from $x - 6y + 2$.
3. Subtract $3x^2 - 5x + 6$ from $2x^2 - 2x - 3$.
4. Add $3xy + 2x - 4y$ to $7 - 3x - 8xy$.
5. Subtract $5x - 6$ from $9x^2 - 2x - 8$.
6. Find the sum of $3x + 6$, $5 - 2x$ and $8x - 9$.
7. Find the sum of $3x - 4y + 3z$ and $x - 3y - 8z$.
8. Subtract $3a^3 + 2a^2 - 6$ from $4a^2 - 2a - 8$.
9. Add $3x^2 + 7xy - 5y^2$ to $8x^2 - 9xy - 3y^2$.
10. From $6a^2 - 7ab - 12$ take $-4ab + 2$.

Example (ii)*:*
Show that $3(x - 8) - 2(5x - 3) = -7x - 18$.

Solution:

$$\begin{aligned}\text{L.H.S.} &= 3(x - 8) - 2(5x - 3)\\ &= 3x - 24 - 10x + 6\\ &= -7x - 18\\ &= \text{R.H.S.}\end{aligned}$$

Figure 7.4 The homework exercise sheet

displayed in Figure 7.4. After the questions on the board are discussed, the teacher gives the answers to the homework. Following this, the teacher demonstrates the new content of the lesson and the students are directed to complete the first three questions from the next exercise on the worksheet, "EXERCISE 2.2". The new content involves simplification of algebraic expressions by removing brackets and collecting 'like terms'. After the teacher works through the three problems on the board, he demonstrates two word problems which involve the same process. While the students are copying these examples, a student query reveals that the teacher has made an error in one of the problems. The teacher corrects the mistake and the students are directed to work through "EXERCISE 2.2" and "EXERCISE 2.3". These exercises are to be completed for homework.

7.21 The Curriculum Macrogenre and the Lesson Genre

Lesson C1 realises the Curriculum Development stage of the curriculum macrogenre. As the students complete questions on the new content of the lesson, the lesson genre is a 'Theory/Practice Lesson' as displayed in Table 7.1.

Table 7.1 The stages of the curriculum macrogenre and the constituent lesson genres

STAGES	LESSON GENRE
Curriculum Initiation	Review Lesson
Curriculum Development	Theory Lesson **Theory/Practice Lesson** Practice Lesson Practical Lesson
Curriculum Application	Theory Applications Lesson Theory/Practice Applications Lesson Practice Applications Lesson Practical Applications Lesson
Curriculum Review	Topic Review Lesson
Curriculum Evaluation	Test/Examination Test/Examination Followup

The objectives of Lesson C1 are located in the Number strand from Mathematical Development 3.4.

Objective N3.11 Investigate number situations and patterns which lead to generalisations, including:

(i) the equalities
$a - (b - c) = a - b + c$ ...

(Curriculum Directorate, 1989, p. 33)

We may note that this unit is most typically completed by 'more able' students in the first half of Year 9. In Lesson C1, however, the students are completing this work in the third term of Year 10. As this class was ranked as a 'more able' class in School C, the conceptual level of the mathematical content indicates that these students are well behind their counterparts in Schools A and B. The teacher of Lesson C1 explained to me that as the majority of these students had failed the previous unit, it was decided to embark on a review program rather than proceed with new content. The teacher also informed me that the class in Lesson C2 was more typical of a 'more able' class.

7.22 The Microgenres

The sequence of microgenres constituting Lesson C1 is given in Figure 7.5. These microgenres are listed below in order of first appearance.

2. **Settling into Work (SIW)**
   PRE-LESSON GENRE
1. **Teacher Preparation (TP)**
   PRE-LESSON GENRE
3. **Student Conversation (SC)**
   PRE-LESSON GENRE
4. **Teacher Conversation (TC)**
   PRE-LESSON GENRE
24. **Student Review Task (SRT)**
   PRELIMINARY GENRE
15. **Student-Student Private Interaction (SSPI)**
   INTERPOLATED GENRE
9. **Student Interruption (SI)**
   INTERPOLATED DISRUPTIVE GENRE
19. **Homework Check (HCh)**
   PRELIMINARY GENRE
14. **Teacher-Student Private Interaction (TSPI)**
   INTERPOLATED GENRE

8. **Teacher Disciplinary Interruption (TDI)**
INTERPOLATED DISRUPTIVE GENRE
23. **Diagnostic Activity (DA)**
PRELIMINARY GENRE
25. **Student Review Task Discussion (SRTD)**
PRELIMINARY GENRE
20. **Review (R)**
PRELIMINARY GENRE
11. **Teacher Side Play (TSP)**
INTERPOLATED DISRUPTIVE GENRE
30. **Homework Discussion (HD)**
PRELIMINARY GENRE
12. **Liminal Activities (LA)**
INTERPOLATED GENRE
5. **Outside Interruption (OI)**
INTERPOLATED DISRUPTIVE GENRE
34. **Board Demonstration (BD)**
MAIN LESSON GENRE
35. **Seat Work (SW)**
MAIN LESSON GENRE
13. **Teacher-Student Private-Public Interaction (TSPPI)**
MAIN LESSON GENRE
36. **Seat Work Discussion (SWD)**
MAIN LESSON GENRE
28. **Copying Notes (CN Resumption)**
MAIN LESSON GENRE
7. **Student Disruption (SD)**
INTERPOLATED DISRUPTIVE GENRE
32. **Teacher Narrative (TN)**
MAIN LESSON GENRE
46. **Closure (C)**
END OF LESSON GENRE

As seen in the graphical display in Figure 7.5, Lesson C1 consists of multiple microgenres that are short-lived. The continual movements between these microgenres well exceed the patterns found in Lesson B while the clear structure of Lesson A with its progressive stages is obviously missing. The result is that Lesson C1 consists of short episodes rather than a global structure such as that found in Lesson A. For instance, the homework is collected with "a minimum of fuss" in Lesson A so that the new content of the lesson may be foregrounded in the initial stages of the lesson. In Lesson B, the homework is not collected nor checked, but extensively reviewed. In Lesson C, the time allocated to checking and marking of the homework in combination with the completion of review questions means that the new content of the lesson does not feature as the field of the discourse until halfway through the lesson in clause time. Even then the multiple interruptions mean that the lesson does not progress in an orderly fashion.

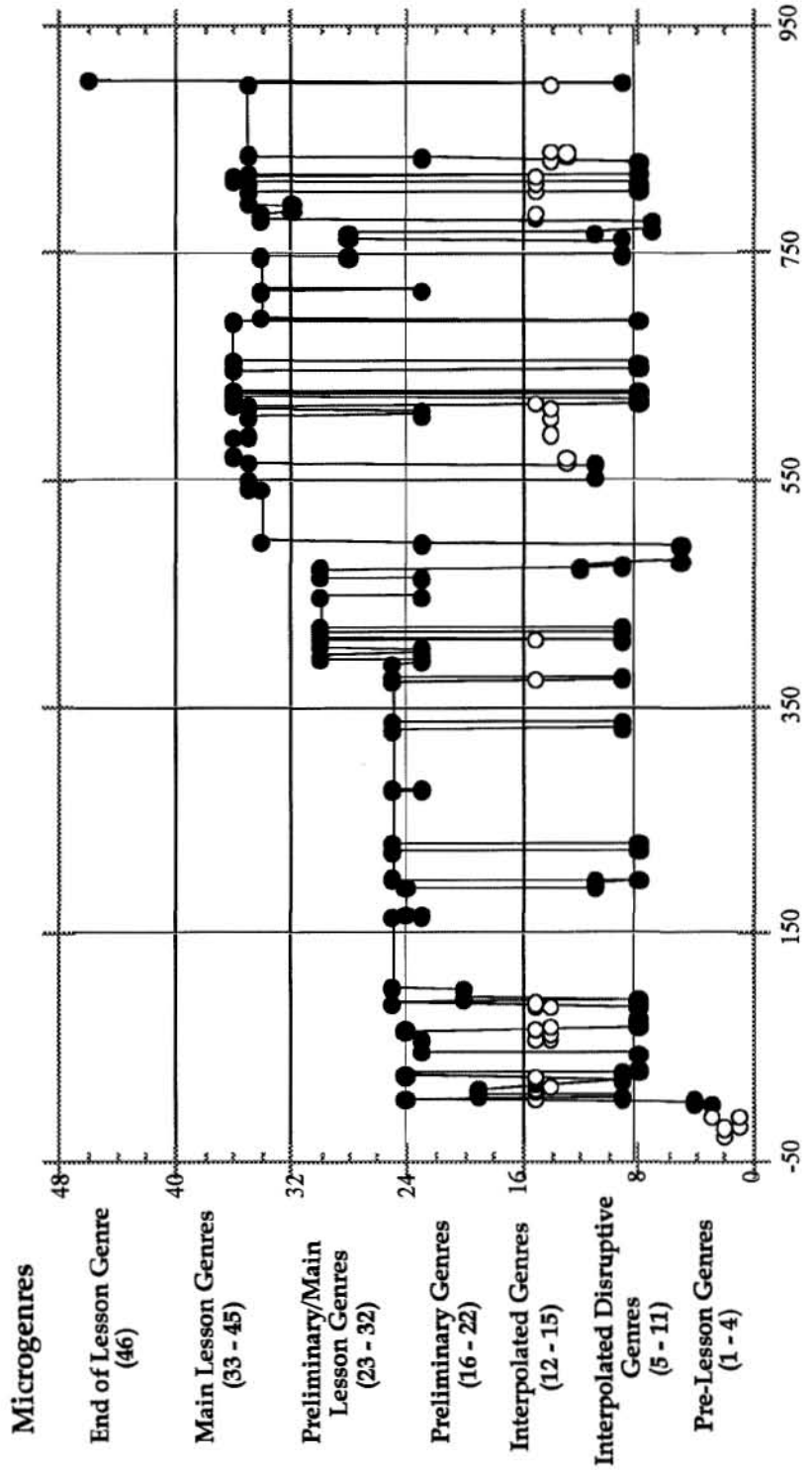


Figure 7.5 Lesson C1- The sequence of microgenres realising the lesson genre

To →, From ↓

	SC	TC	OI	SD	TDI	SI	TSP	LA	HCh	R	DA	SRT	SRTD	CN	HD	TN	BD	SW	SWD	C
SC		1																		
TC												1								
OI											1									
SD																	1			
TDI					1					1	2		3				1	2	3	
SI			1		1			1	2				2	1	2					1
TSP				1	1													1		
LA						2														
HCh						1						1								
R													1							
DA												2	1		3		2	2		
SRT					1	2	1													
SRTD					2	2					3									
CN						1	1													
HD						2		1			2									
TN																		1		
BD											1			1		1		1		
SW					2	1	1				1								3	
SWD					5													1		
C																				
Total		1	1	1	13	11	3	2	2	1	10	4	7	2	5	1	4	8	6	1

Figure 7.6 Lesson C1 - The transition matrix

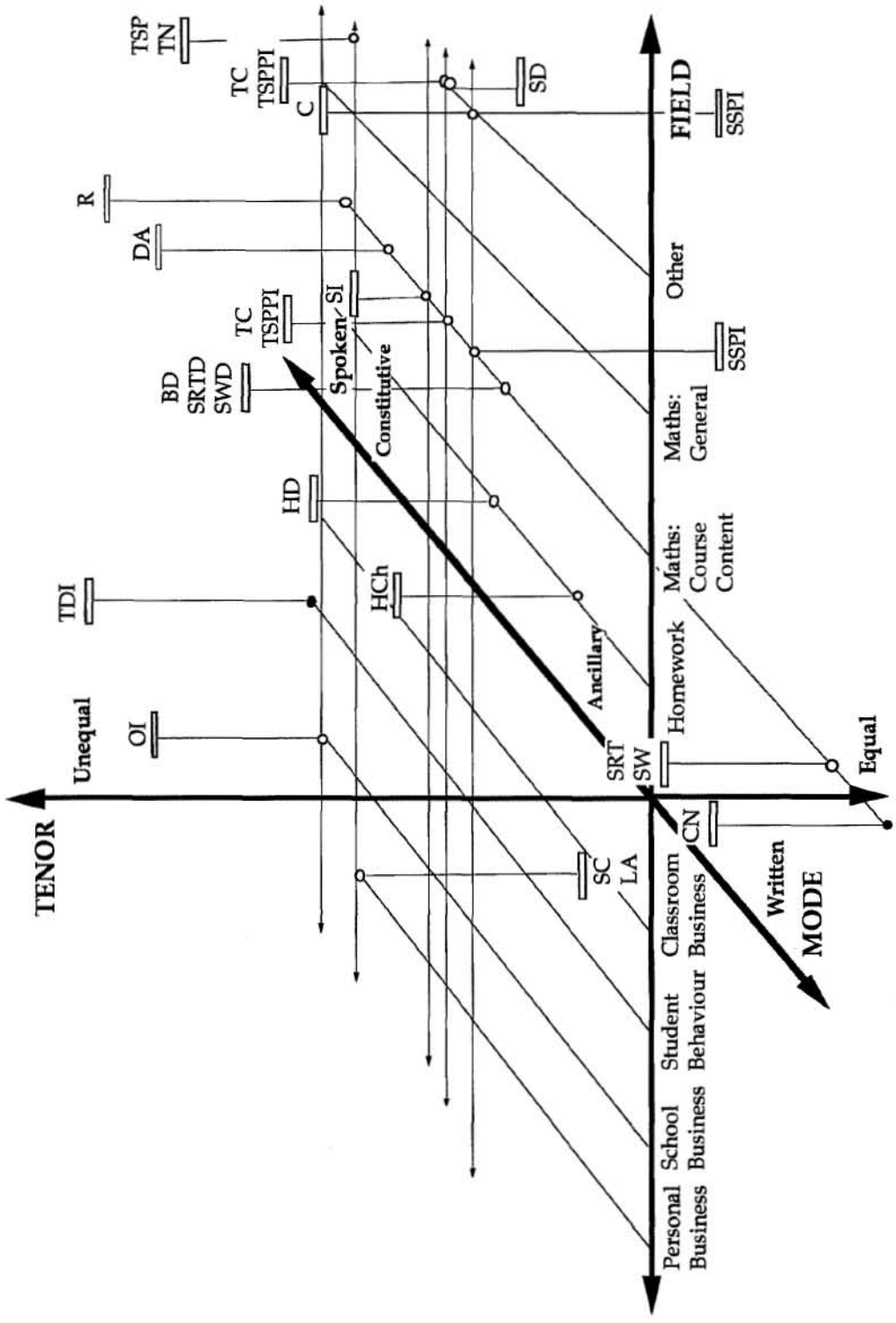


Figure 7.7 Lesson C1 - Dimensions of the microgenres

The microgenre transition matrix for Lesson C1 given in Figure 7.6 highlights the wide range of microgenres and the multiple transitions between the different states. The high number of identical movements between particular microgeneric states exceeds that found in Lesson B and the patterns are diametrically opposed to the single movements found in Lesson A. Further to this, the most frequently occurring microgenres are Interpolated Disruptive Genres in the form of Teacher Disciplinary Interruption and Student Interruption. This includes five occasions where the teacher interrupts the Seatwork Discussion with disciplinary action and two occasions where the Seatwork and the Student Review Task Discussion are similarly disrupted. The students interrupt a range of microgenres including Liminal Activities, Student Review Task, Student Review Task Discussion and Homework Discussion. Significantly these disruptive microgenres realise surges of interpersonal meaning.

The range of microgenres of Lesson C1 is revealing. For example, Teacher Side Play does not occur in any of the other lessons. In this microgenre, the teacher introduces new register selections to divert the flow of the current microgenre. In Lesson C1, on two occasions the teacher jokes after making an error (clause 192 and 768) and on a third occasion, he teases a student about enjoying the lesson after making an enquiry about her bruised hand (clause 551). Unlike any of the other lessons, Liminal Activities are realised between Main Lesson Genres. This may be compared to Lesson A where the structure is so tight that there is not time for such interpolated activities. In addition, Outside Interruption occurs when a student arrives late for the lesson. Further disruption occurs in locating a desk and chair for this student and then securing a copy of the worksheet.

From this overview of the microgenres of Lesson C1, it is apparent that the focus of the lesson is not always directed towards the course content. In addition, although it appears that the Tenor relations show variation, I demonstrate in the linguistic analysis that new patterns of deference predominate. The wide range of register selections of the microgenres of Lesson C1 are illustrated in Figure 7.7.

7.23 Interpersonal Meaning

I have indicated in the titles of Chapters 5, 6, 7 and 8 that the lessons are orientated towards achieving two social goals simultaneously. The students

in Lesson A and Lesson B are involved in learning both mathematics and gender constructions. To differing degrees, I believe that each of these goals are realised. On the other hand, I have conceptualised the social goals of Lessons C1 and C2 as learning mathematics and learning submission. In what follows, I argue that the prominence of the patterns of interpersonal meaning in Lesson C1 raises serious doubt as to the importance of the goal of learning mathematics in Lesson C1. The above observations resonate with the views of critical educationalists (Apple, 1982; Bernstein, 1990; Foucault, 1979/1991; Freire, 1974; Giroux, 1989; McLaren, 1989 for example).

7.231 General Lexicogrammatical Patterns, NEGOTIATION and Interpersonal Metaphor

As for Lesson B and C2, the transcript of Lesson C1 in Appendix 4(i) includes private interactions between the teacher and the students. Unless specifically stated, these interactions marked with a projection of "**" are not included in the analyses.

The major features of the exchanges of Lesson C1 are displayed below in Table 7.2. The exchanges in Lesson C1 follow Lesson B in terms of brevity but lead the field with respect to the number of student initiated exchanges. While relatively minor, nevertheless it appears that students in Lesson C1 demonstrate greater power than other students in terms of their control of the exchanges. Because this feature of Lesson C1 deserves closer inspection, the first clause of the exchanges initiated by the students are listed below in Table 7.3.

Table 7.2 Exchange structure

NATURE OF EXCHANGES	
Number of Exchanges	257
Average Length of Exchange	2.91 clauses
Teacher Initiated Exchanges	239
Student Initiated Exchanges	18
Ratio of teacher: student clauses	1:0.27

The exchanges initiated by the students tend to occur in groups at particular stages of the lesson as evidenced by the clause and exchange numbers. In a manner reminiscent of the student initiative which opens the Homework Discussion in Lesson B, at the commencement of Lesson C1 a student query

Table 7.3 First clause in student initiated exchanges

Clause N^{o}/ Speaker	Exchange N^{o}	Clause
7 S?	2	// sir are you going to check the homework
21 S *	5	// hey sir sir
28 S1 *	7	// sir
64 S *	18	// [in the brackets] [for the second one] is that /ah/ minus three [['x' cubed]]
332 S?	92	// sir sir
375 S?	101	// why do you use the calculator
412 S? *	114	// where are we starting from
470 S?	140	// and what [about number six]
474 Ben	141	// sir
489 S? *	147	// there 's one
491 Shn *	148	// can I get another chair sir
661 Ben	197	// and when you have a negative
666 Ben	198	// and what [about [in number three]]
749 S1? *	229	// sir <indistinct>
750 S1? *	230	// shouldn't [[that three 'x' take three]] be ah/ first
769 S?	237	// <indistinct> candid camera or what
836 Lis *	255	// is that right
900 Gln	256	// sir

concerning the checking of the homework (clause 7) leads to the microgenre of Homework Check. During this microgenre, an unwelcome student bid (clause 21) is met by the teacher response "just a minute" (clause 22). The teacher response to a second bid (clause 28) is indistinct. Regardless of what this response may have been, the teacher reply (clause 29) effectively ends the exchange. In the next student initiated exchange, a student successfully seeks clarification of a term in the algebraic expression written on the board (clause 64).

The next group of student initiated clauses occurs in the middle of the lesson. A student bid (clause 332) interrupting the Student Review Task Discussion is met by the teacher response, "look there's no film in it today, alright" (clauses 334 and 335). This sardonic reference to the video camera halts the exchange. The Student Review Task Discussion is again interrupted by a student with a question concerning the use of calculators (clause 375). This is met by the dry reply "to get it right Lisa" (clause 376). At the beginning of the marking of the homework in the Homework Discussion microgenre, a student enquires where the teacher is starting from (clause 412). The teacher gives the solution to the problem (clause 414) which indicates question one. This results in private interactions amongst

the students and laughter (clause 416). In another student initiated exchange concerning the homework, a request for a repetition of an answer (clause 470) meets with success. Other student initiated exchanges concern locating a desk and chair for the late student (clause 489 and 491). After responding to the student initiated request (clauses 661 and 666) for clarification of the new content, the teacher comments "we all do it mate" (clause 687).

In the final stage of the lesson, two student initiated exchanges (clauses 749 and 750) reveal that the teacher has made a mistake in the solution of one of the word problems. This arouses some humour in the class (clause 769). The other student initiated exchanges occur in the Seatwork microgenre when students seek help from the teacher (clauses 836 and 900).

Given that the student initiated exchanges generally function to disrupt the present microgenre, the teacher must either act on the student initiative or effectively squash it. In Lesson C1, the teacher adopts one of several strategies to ensure that student bids for control are short-lived. If perceived as legitimate and occurring at an opportune time, the teacher acts upon the student initiative as in the case of the student enquiry concerning the checking of the homework. On the other hand, student bids which occur at inopportune times end abruptly, as for example when the teacher commands the student to wait. The teacher's most effective strategy in squashing unwelcome student initiatives is, however, the use of sarcasm. This strategy effectively cuts the student initiative while at the same time maintaining group solidarity through humour. While there is no need for any such strategy in Lesson A, a radically different approach to student control is found in Lesson B. As discussed, teacher strategies in this lesson to curb unwanted behaviour involve genteel politeness and patience. In Lesson C1, sarcasm and dry humour abound to the extent that the interpersonal relations between the male teacher and working class group of students are shaped by this method of control.

As for each lesson, the power of the teacher is evident from his role of primary knower and secondary actor as displayed in Table 7.4 below. However, the speech role of the students as secondary knower indicates that over half of the responses are chorus responses as indicated by the classification 'K3' and 'Kn'. The relative frequency of these types of responses is only exceeded in Lesson C2. This represents a new pattern of

deference in the lessons of working class students. In Lesson A it may be recalled that there were no chorus responses while in Lesson B they form the minority of the responses. In Lessons C1 and C2, however, the majority of student contributions are made on a group basis. This indicates a lack of individual responsibility for classroom contributions. Interpersonally the students are positioned as members of a group whose few contributions are characterised by their brevity.

Table 7.4 Speech roles of the teacher and students

Ranking Clauses: SPEECH ROLES (n = 749)	Teacher		Student	
	Total	Percentage (1 d.p.)	Total	Percentage (1 d.p.)
Knowledge (n = 615)	471	62.9	144	19.2
Primary Knower (dK1, K1, K1f)	444	59.3	11	1.5
Secondary Knower (K2, K2f)	27	3.6	86	11.5
Secondary Knower (K3, Kn)			47	6.3
Action (n = 134)	121	16.2	13	1.7
Primary Actor (dA1, A1, A1f)	14	1.9	12	1.6
Secondary Actor (A2, A2f)	107	14.3	0	0.0
Secondary Actor (A3, An)			1	0.1

The selections of SPEECH FUNCTION are given below in Table 7.5.

Table 7.5 Selections of SPEECH FUNCTION

Ranking Clauses: SPEECH FUNCTION	The Lesson		Teacher Contribution		Student Contribution	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
	749	**100**	**592**	**79.0**	**157**	**21.0**
Knowledge	**615**	**82.1**	**471**	**62.9**	**144**	**19.2**
Calls	25	3.3	18	2.4	7	0.9
Propositions	438	58.5	343	45.8	95	12.7
Dynamic Moves	97	13.0	78	10.4	19	2.5
Follow-up	25	3.3	22	2.9	3	0.4
Reacting	30	4.0	10	1.3	20	2.7
Action	**134**	**17.9**	**121**	**16.1**	**13**	**1.7**
Proposals	103	13.8	100	13.4	3	0.4
Dynamic Moves	27	3.6	17	2.3	10	1.3
Follow-up	4	0.5	4	0.5	0	0.0
Reacting	0	0.0	0	0.0	0	0.0

As for all lessons, moves associated with knowledge dominate the discourse of Lesson C1. Although comparable with Lesson A and Lesson C2, the number of student contributions in these knowledge moves is the highest found in all four lessons. However, although students contribute slightly more often, as already suggested the nature of the contributions realise deference as opposed to dominance.

The relatively low incidence of Dynamic Moves accounts for the relatively short length of the exchanges. On the other hand, incidences of Reacting are found most often in Lesson C1. This is not surprising given the number of teacher responses which are designed to invoke humour.

The selections for SPEECH FUNCTION and MOOD in Lesson C1 are listed below in Table 7.6. These selections are more delicately displayed according to speech role of the teacher and student in Tables 4(ii).1 to 4(ii).8 in Appendix 4(ii).

Table 7.6 SPEECH FUNCTION and MOOD: Teacher and student contributions

	KNOWLEDGE						ACTION				
TOTAL	Call	Prop-ositn	Dyn-Move	Foll-Up	Rea-cting	Total	Prop-osal	Dyn-Move	Foll-Up	Rea-cting	Total
Decl-arative 492 65.7%	4	317	69	14	12	416 55.5%	57	17	2		76 10.1%
Teacher	3	245	57	13	7		55	10	2		
Student	1	72	12	1	5		2	7			
YN-interrog 36 4.8%	1	23	3			27 3.6%	8	1			9 1.2%
Teacher	1	17	2				7				
Student		6	1				1	1			

WH-interrog 87 11.6%	2	66	18			86 11.5%		1			1 0.1%
Teacher	2	60	14					1			
Student		6	4								
Imper-ative 60 8.0%	2	11	3	2		18 2.4%	38	4			42 5.6%
Teacher	2	4	2	2			38	4			
Student		7	1								
Exclam-ative 6 0.8%		1		2	3	6 0.8%					0 0.0%
Teacher											
Student											
Explet-ive 1 0.1%					1	1 0.1%					0 0.0%
Teacher					1						
Student											
Paraling-uistic 20 2.7%		3	1	1	14	19 2.5%		1			1 0.1%
Teacher											
Student		3	1	1	14			1			
Minor Clause 47 6.3%	16	17	3	6		42 5.6%		3	2		5 0.7%
Teacher	10	16	3	5				2	2		
Student	6	1		1				1			
749 100%	25	438	97	25	30	615 82.1%	103	27	4		134 17.9%

The patterns of selections from the systems MOOD and SPEECH FUNCTION realise deference. Firstly, proportionally more instances of paralinguistic behaviour are found in Lesson C1 than in any other lessons. The move Reacting in the form of laughter accounts for this phenomenon. As suggested, the teacher strategies of control have significant impact on the nature of the discourse. In addition to exclamative, this includes one instance of an expletive "hooley dooley" (clause 30) which occurs when the teacher spots some graffiti on the hands and arms of a female student. These moves and MOOD selections realises surges of interpersonal meaning which reverberate across the whole class.

Interpersonal metaphor realised through the systems of MOOD and SPEECH FUNCTION is examined from the point of view of tagged declaratives, teacher commands and student responses to questions. In the first case, the fifteen tagged declaratives found in Lesson C1 are listed below in Table 7.7. With minor exceptions including the sardonic "it's very hard isn't it" (clause 541), the majority of tags are "please". As opposed to coercing agreement with the content of the lesson, these function in imperative and declarative commands as patterns of deference realising what is known in western culture as politeness.

Table 7.7 Mood Tags

Clause N^{o}/ Speaker	MOOD TAG
5 T	// and do those three **please**
56 T	// hurry up **please**
70 T*	// will you finish it **please**
80 T*	// could you start your work **please**
178 Lis	// the negative **sorry**
192 T	// nothing like [[thinking of the answer[[you 're waiting [for someone [[to say]]]]]]] **is there**
215 T	// when you multiply them **please**
404 T	// put the answer in **please**
541 T	// it 's very hard **isn't it**
545 T	// do numbers one and two and three **please**
588 T	// and do the same [for two and three] **please**
624 T	// (make sure) you 've got the process exactly right **please**
690 T	// now can you settle **please**
746 T	// we don't say that **do we**
819 T	// quieten [over here] **please**

The descending order of frequency for selections of Mood Tags is Lesson B, Lesson C2, Lesson C1 and Lesson A. As the students in Lesson B and the teacher in Lesson C2 are female, it appears that interpersonal metaphor in the form of tagging is a pattern of deference which may be gender specific.

As displayed in Table 4(ii).6 in Appendix 4(ii), over one third of the Initiating moves of commands are declaratives and over ten percent are polar interrogatives. Of the Continuing moves, the majority are imperatives, though the pattern is not as marked as for Lesson B. The degree of interpersonal metaphor realised in Lesson C1 through teacher commands is therefore comparable to the incongruence found in Lesson B.

The two imperative commands with a Mood selection found in Lesson C1 are listed in Table 7.8. In each case the Subject "you" has been selected for extra interpersonal emphasis. There are no second order imperatives with Subject "let's" which function to create a group identity which includes the teacher. The teacher maintains his position as one quite distinct from that of the students. As will be seen, this atmosphere of division between the teacher and the students is tempered through the use of alternative strategies in Lesson C1.

Table 7.8 Imperative commands with MOOD structure

Clause N^{o}/ Speaker	Subject	Residue
567 T *	you	// leave the bracket [[as it is]]
584 T	you	// just follow your collecting like terms procedure

The nature of the interactions between the teacher and the students is illustrated by the excerpt given in Table 7.9. As previously mentioned, the exchanges tend to be brief with few Dynamic Moves. Students initiate Dynamic moves on five occasions and respond to teacher initiative on six occasions. However, students make proportionally more requests through Dynamic moves in Lessons C1 and C2. All student Dynamic moves however, tend to be brief with no Continuation moves and few K-x moves. In addition, the students answer in chorus with contributions that are typically brief. This is reminiscent of the perfunctory nature of the interactions in Lesson B.

Table 7.9 Moves, stages of exchange structure, SPEECH FUNCTION, MOOD selections

Clause No/ Speaker	Ex-change	Clause	MOVE, SPEECH ROLE, STRUCTURE, SPEECH FUNCTION, MOOD
247 T	66	// how many letters	Proposition, K1, K-x, statement, WH-interrogative
248 T	66	// how many of that letter there are [in a multiplication chain]	Proposition, K1, K-x, statement, declarative
249 T	66	// if it 's a five	Dynamic, K1, K-Initiation, clarification, declarative
250 T	66	// you 'd have five 'x's [in a multiplication chain]	Dynamic, K1, K-Continuation, clarification, declarative
251 T	67	// how many letters [in the multiplication chain] here [for 'x']	Proposition, dK1, K-Initiation, question, WH-interrogative
252 Ss		<indistinct>	
253 T	67	// two	Proposition, K1, K-Response, acknowledgment, declarative
254 T	68	// and how many here	Proposition, dK1, K-Initiation, question, WH-interrogative
255 Ss	68	// three	Proposition, Kn, K-Response, answer, declarative
256 T	69	// so all together how many would be [in the multiplication chain] [for 'x']	Proposition, dK1, K-Initiation, question, WH-interrogative
257 Ss	69	// five	Proposition, Kn, K-Response, answer, declarative

A summary of the nature of the clauses of Lesson C1 and the teacher and student contributions are given in Table 7.10 and 7.11 respectively.

Table 7.10 Clausal analysis

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	731	100
MAJOR CLAUSES	675	92.3
Complete	482	65.9
Ellipsed	179	24.5
Abandoned	14	1.9
MINOR CLAUSES	56	7.7
NON-CLASSIFIED/UNKNOWN CLAUSES	50	

Table 7.11 Clausal analysis: Teacher and student contributions

	Teacher		Student	
	Total	% (1 d.p.)	Total	% (1 d.p.)
CLASSIFIED CLAUSES (Total 731)	591	80.8	140	19.2
RELATIVE PERCENTAGES	591	100	140	100
MAJOR CLAUSES	549	92.9	126	90.0
Complete	435	73.6	47	33.6
Ellipsed	101	17.1	78	55.7
Abandoned	13	2.2	1	0.7
MINOR CLAUSES	42	7.1	14	10.0
NON-CLASSIFIED/UNKNOWN CLAUSES	8		42	

Although comparable with Lesson C2, we have here the highest incidence of ellipsis in all four lessons, with nearly one quarter of all clauses realising some form of ellipsis. If the student contributions are considered separately as displayed in Table 7.11, it may be seen that over fifty percent of all student clauses involve ellipsis. This indicates that the oral discourse of Lesson C1 does not accord with the formal discourse of mathematics. Further to this, linguistic selections realise colloquial familiarity as will be seen in the analysis of the lexical items of Lesson C1.

Table 7.12 Modality and modulation

(n = 619)	Totals	Percentage (1 d.p.)
MODALITY	527	85.1
Probability	527	
Usuality		
MODULATION	92	14.9
Obligation	75	
Inclination	8	
Potentiality	9	

The modality and modulation values for ranking and non-ranking clauses are summarised in Table 7.12. Clauses involving ellipsis have not been

Table 7.13 Probability: Modality

ORIENTATION/ VALUE (n = 527)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal	459 (87.1%)	2 (0.4%)	2 (0.4%)	22 (4.2%)
High	8 (1.5%)			
Medium	1 (0.2%)	1 (0.2%)	22 (4.2%)	3 (0.6%)
Low			7 (1.3%)	

Table 7.14 Probability: Explicit realisation of modality

Clause Nº/ Speaker	Clause	Value and orientation
33 T*	// **I don't want**	maximal, absolute, subjective
146 T	// **it 's only** the numbers [at the front] that change	maximal, absolute, objective
177 Lis	// **I mean**	maximal, absolute, subjective
193 T	// OK **I think**	maximal, absolute, subjective
226 T	// **I just like**	maximal, absolute, subjective
390 T	// **I 'm impressed**	maximal, absolute, subjective
448 T	// first **I want**	maximal, absolute, subjective
503 T	// and **it 's just because** they have a different shape	maximal, absolute, objective
555 T*	// **you reckon**	maximal, absolute, subjective
558 T*	// **you don't want**	maximal, absolute, subjective
561 T*	// **I know**	maximal, absolute, subjective
562 T*	// **I know**	maximal, absolute, subjective
626 T	// **I still want** quiet	maximal, absolute, subjective
644 Gln	// yes **I know**	maximal, absolute, subjective
720 T	// how **do you think**	maximal, absolute, subjective
722 T	// **who would like**	median, probable, subjective
723 T	// to take a reasonable guess [[at what **is likely** to happen]]	median, probable , objective
731 T	// **who reckons**	maximal, absolute, subjective
774 T	// **I thought**	maximal, absolute, subjective
776 T	// but oy oy oy **I would like**	median, probable, subjective
793 T	// OK now since **you know**	maximal, absolute, subjective
798 T	// and if **you 're really nice**	maximal, absolute, subjective
808 T	// **I just feel**	maximal, absolute, subjective
810 T	// **I 'd rather**	median, probable, subjective
822 T*	// **you know**	maximal, absolute, subjective
825 S? *	// that 's [[why **I thought**]]	maximal, absolute, subjective
827 T *	// **I am sorry**	maximal, absolute, subjective
828 T*	// **I forgot**	maximal, absolute, subjective

included unless the modality or modulation is explicitly realised. As may be seen, modality is exclusively orientated towards probability and modulation predominantly towards obligation. This same trend appears in all the lessons analysed in this study.

A summary of the values of modality realised in Lesson C1 is displayed in Table 7.13 above. The modality associated with probability is the highest found in any of the four lessons as metaphorical realisations are minimal in Lesson C1. That is, in 87.1% of cases there is no play of modality. This results in a tone of absolute certainty in Lesson C1. The twenty eight cases of explicit modality are listed in Table 7.14. It may be seen that explicit modality is largely subjective and realised through 'thinking' and 'knowing'. Of these, twenty four realise maximal values. Taking this in conjunction with the eight cases of high modality, overall the discourse is imbued with certainty which leaves little room for negotiation.

Apart from the nine cases of potentiality which realise low implicit subjective values, modulation is predominantly subjective and implicitly realised as displayed in Table 7.15. There are only six cases where low or median values are realised. Commands therefore do not leave much room for negotiation.

Table 7.15 Obligation: Modulation

ORIENTATION/ VALUE (n = 75)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal	8 (10.7%)		61 (81.3%)	
High				
Medium			1 (1.3%)	
Low			5 (6.7%)	

Inclination, however, does not display such high values as may be seen from Table 7.16. The majority of values are median and explicit. These values result from the uncertainly associated with the future as realised by "will".

Table 7.16 Inclination: Modulation

ORIENTATION / VALUE (n = 8)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal			1 (12.5%)	
High				
Medium			1 (12.5%)	5 (62.5%)
Low			1 (12.5%)	

The nature of the Mood Adjuncts selected in Lesson C1 is summarised below in Table 7.17.

Table 7.17 Mood Adjuncts

	Total	Percentage (1 d.p.)
MOOD ADJUNCT	50	100
Intensity	37	74.0
Degree	2	4.0
Time	7	14.0
Presumption	1	2.0
Probability	3	6.0
Usuality		
Ranking Clauses	44	88.0
Rank-shifted Clauses	6	12.0
Mood Adjuncts per ranked clause (n = 749)	$\frac{50}{749} = 0.07$	
Thematic Mood Adjuncts	11	22.0
Student contribution	3	6.0

The relatively low frequency and restricted range of these adjuncts in Lesson C1 compared to Lesson A and B and the similarity of the patterns found in Lesson C2 indicates the limited functionality of these adjuncts in colouring interpersonal meaning in lessons with working class students. This appears to be one facet of a restricted code. In Lesson C1, the adjuncts that do occur

are largely orientated towards lowering intensity as realised by "just" and to a lesser extent, emphasising dimensions of time. This orientation of Mood Adjuncts towards low intensity is a feature of mathematical pedagogical discourse. It seems that both the teacher and students are acutely aware of the complexities of the discourse and choose adjuncts that downplay the intensity of what is being said. In Lesson C1, these adjuncts are not foregrounded to the same extent as in Lesson B where over thirty percent of all Mood Adjuncts were components of the Theme.

There is only one Comment Adjunct in the oral discourse of Lesson C1, "hopefully" (clause 553). This occurs in conjunction with the comments pertaining to a student's bruised hand.

As for all lessons, the Polarity selections are overwhelmingly positive. This is a feature of pedagogical discourse, at least that which is open to public viewing.

Table 7.18 Polarity

POLARITY	Total	Percentage (1. d.p.)
Total	703	100
Positive	667	94.9
Negative	36	5.1

The orientation of the lexical items of address, fixed expressions, colloquialisms, slang terms, anaphoric nouns and attributes is summarised in Table 7.19. While the trend of neutrality is maintained in Lesson C1, significantly at the same time this lesson has the highest incidence of lexical items that function covertly. The occurrence of these items is directly linked to the teacher's use of irony and sarcasm to maintain control in the class. Thirteen of the covert items function as dysphemisms and one as a dysphemic euphemism. These lexical items which function covertly as dysphemisms are highlighted in Table 7.20 below.

The expletive "hooley dooley" (clause 30) is classified as an euphemistic dysphemism as it replaces more direct dysphemisms such as 'bloody hell' or 'holy Christ'. In making this comment, as previously mentioned the teacher is reacting to the graffiti on a female student's hand. Despite the euphemistic ring of this selection, the student is nevertheless being made

Table 7.19 Orientation of lexical items

	Total	Percentage (1. d.p.)
LEXICAL ITEMS	206	100
NEUTRAL	144	69.9
OVERT	7	3.4
Positive	5	
clined	5	
laudatory		
Negative	2	
clined	1	
condescending		
critical	1	
COVERT	55	26.7
Euphemism	42	
straight-euphemism	41	
dysphemic -euphemism	1	
Dysphemism	13	
straight-dysphemism	5	
euphemistic -dysphemism	8	

Table 7.20 Dysphemic expressions

Clause N^{o}/ Speaker	Dysphemic Expression	Classification of Expression
30 T*	//**hooley dooley**	covert, dysphemism, euphemistic
71 T*	// don't worry **[about her]**	covert, dysphemism, straight
74 Mar*	// but **she** <indistinct>	covert, dysphemism, straight
75 T*	//**what 's your problem** Sharmane	covert, euphemism, dysphemic
76 Sha*	//**I don't have a problem**	covert, dysphemism, straight
156 T	//and **you great dill**	covert, dysphemism, euphemistic
218 T	//**great**	covert, dysphemism, euphemistic
354 T	//**tricky**	covert, dysphemism, euphemistic
373 T	// <indistinct> **brilliant**	covert, dysphemism, euphemistic
528 T	// but it is **too time consuming and fiddly** [[to do that]]	covert, dysphemism, straight
541 T	// it 's **very hard** isn't it	covert, dysphemism, straight
557 T*	//**such a stimulating maths lesson**	covert, dysphemism, euphemistic
687 T	//**we all do it**	covert, dysphemism, euphemistic
766 T	// and it 's going to change **the whole darn thing**	covert, dysphemism, euphemistic

the object of ridicule through covert criticism. Later in the lesson, a student complains about the behaviour of this same student to the teacher. The teacher's comment is again dysphemic with selection of "her" (clause 71). The student follows suit with the use of a pronoun "she" (clause 74). The teacher directly addresses the student with "what's your problem" (clause 75) to which the student quickly replies "I don't have a problem" (clause 76). After pouting and complaining that she doesn't understand the work, the teacher helps the student on a private basis. In doing so, the teacher deflects the potential conflict that no doubt he senses is about to arise.

I believe that other dysphemisms function to undermine student confidence in coping with the mathematical content. Euphemistic dysphemisms such as "great" (clause 218), "tricky" (clause 354), "brilliant" (373) "it's very hard" (clause 541) in response to student answers and the level of difficulty of the mathematics function sarcastically to realise the opposite meaning. After a student query leads to a protracted discussion, the teacher comment "we all do it" (clause 687) functions covertly to express impatience at the student's perceived stupidity. On the other hand, in order to deflect criticism over his own mistake, the teacher selects the euphemistic dysphemism "the whole darn thing" (clause 766) for the problem on the board.

The teacher controls the class largely through these covert strategies involving sarcasm. While the humour may prevent the interpersonal relations from disintegrating, the cost is enormous. Not only is subservience learnt, but also covertly manifested is the view that mathematics is too difficult for the majority of these students. It may be recalled that the opposite view is promoted in Lesson A with its high levels of presumption and non-acceptance of any form of excuse. In Lesson B, difficulties are related to external factors.

The covert strategies of sarcasm filter through entire exchanges. For instance, in the excerpt below the teacher is reprimanding a student who presumably is not paying attention.

224	T	// sorry
225	T	// I 'm going so fast Terry
226	T	// I just like
227	T	// things to be clear
228	Ss	// <laughter>
229	T	// it 's for my benefit

A congruent version such as 'I do not apologise for going so slow, I want to make sure things are clear. It's for your benefit' would not result in the laughter that was recorded in clause 228. The sarcasm thus operates to create a target at whom ridicule is directed. While squashing any potential threat of disruption, the humour smooths tensions for the rest of the class and in doing so creates some sort of group cohesion at the expense of the one individual. Other students are also discouraged from disrupting the proceedings through fear of becoming the object of derision.

Though comparable with Lesson B, items realising amplification occur most frequently in Lesson C1 as summarised in Table 7.21 below. These include iteration in "sir, sir" (clause 21), "I know, I know" (clauses 561, 562) as well as intensification of items which function covertly. These include "you great dill" (clause 156) and "very hard" (clause 541). Other items include fixed expressions such as "no great drama" (clause 709) and general items such as "very important" (clause 706) and "really nice" (clause 798). These items function to realise surges of interpersonal meaning.

Table 7.21 Amplification of general lexical items and register specific items

	Total	Percentage (1. d.p.)
AMPLIFIED LEXICAL ITEMS	20	100
Intensification	15	75.0
straight intensification	15	
hyperbole		
understatement		
Iteration	5	25.0
VARIETY	20	
Standard	13	
Colloquial	6	
REGISTER - mathematics	1	

Apart from the expressions of attitude which are realised covertly, nine items function overtly. These items are listed in Table 7.22 where it may be seen that with the exception of "you great dill" (clause 156), the majority realise praise. Others function to realise regret, hope and commiseration. While some of these attitudes are manifested in Lesson B, none are found in Lesson A.

Table 7.22 Attitudinal lexis

Clause N^{o}/ Speaker	Lexical Item	Category
77 T*	good	standard, variable expression
156 T	you great dill	colloquial, variable expression
218 T	great	colloquial, variable expression
224 T	sorry	standard, variable expression
309 T	good	standard, variable expression
390 T	I 'm impressed	standard, variable expression
553 T*	hopefully	standard, variable expression
612 T*	good	standard, variable expression
698 T	a misery	standard, variable expression

The forms of address selected in Lesson C1 are summarised below in Table 7.23.

Table 7.23 Forms of address

ADDRESS	Total	Percentage (1 d.p.)
Total	52	100
Standard	50	96.2
Colloquial	2	3.8
REAL NAME	35	67.3
given	29	
surname		
full-name	1	
hypocorism	5	
nick-name		
NON-NAME	17	32.7
pronoun		
title		
formal	15	
kin-term		
solidarity	2	
leadership		
general noun		
occupational		
client		
group		
attitudinal		

The types of Vocative selected in Lesson C1 occur in the same proportion as Lesson B. There are twice the number of 'real name' Vocatives as compared

to the number of 'non-name' Vocatives. Once again this trend differs from Lesson A where 'real name' Vocatives are largely selected. In Lesson C1, most of the names are given names. Few hypocorisms realising degrees of intimacy occur. Significantly, those that do occur are addresses made to male students "Des" (clause 92 and clause 610), "Rod" (clause 107), "Terry" (clause 225). The only exception is "Kate" (clause 560).

The teacher's position of dominance is reinforced by the multiple selections of "sir" (clauses 7, 21. 28, 43, 235 for example). As previously noted, teacher selections for a Subject in imperative commands are minimal and second order imperatives realised by "let's" simply do not occur. This line between the primary actor and secondary actor is firmly established with the teacher in the position of power. However, this division within the group is offset by the choice of "mate" as a form of address for the students. As will be seen, this operates in conjunction with colloquial expressions to manifest a spirit of comradeship which disguises the covert manipulation.

Thirty of the total of fifty two are component of the Theme while twenty two function as Vocative Adjuncts. While the incidence of Vocative selections is comparable across Lessons A, B and C1, the foregrounding of personal address is marked in Lesson A. In Lessons B and C1 a larger percentage of the Vocatives function as an added appendage for intensifying interpersonal meaning. This indicates that individuality is more strongly promoted in Lesson A.

The incidence of colloquial expressions is the highest in Lesson C1 and is indeed a feature of the discourse. The nature of these items is summarised below in Table 7.24. Significantly, in Lesson C1 the covert strategies of manipulation operate in tandem with colloquial language with the infamous "hooley dooley" (clause 30) functioning as a slang term. At the same time as the students are being controlled by covert strategies, the colloquial lexical items function to promote familiarity, solidarity and group cohesiveness. That is, the colloquialisms function to align the teacher with the students despite the obvious power differential and manipulative strategies. Ultimately however, this means that students are marginalised with respect to dominant discourses through these patterns of deference. Significantly, these are not the same patterns of deference as found in Lesson B.

Table 7.24 Colloquial expressions

Nature of Colloquial Expression	Total	Percentage (1 d.p.)
	114	100
FIXED EXPRESSIONS	16	14.0
Discoursal - social formula		
Discoursal - structuring		
Catch phrase	12	
Cliche	3	
Idiom	1	
VARIABLE EXPRESSIONS	98	86.0
General	94	
Attitudinal lexis	2	
Address	2	

The range and types of the fixed expressions are summarised in Table 7.25 and are listed in Table 7.26 below. Given the nature of the items, I propose that these fixed expressions operate as another dimension of a restricted code. These are catchy phrases such as one would find in advertising campaigns as opposed to more formal discourse.

Table 7.25 Fixed expressions

Nature of Fixed Expression	Total	Percentage (1 d.p.)
	21	100
VARIETY		
Standard	4	19.0
Colloquial	16	76.2
Slang	1	4.8
CATEGORY		
1. catch-phrase	13	
2. cliche	3	
3. idiom	1	
4. proverb		
5. quotation		
6. discoursal	4	
social formula	1	
structuring	1	
comment adjunct		
gambit	1	
stylistic form		
stereotype	1	

Table 7.26 Fixed expressions of Lesson C1

Clause N^{o}/ Speaker	Fixed Expression	Classification
30 T*	hooley dooley	slang, catch phrase
35 T*	that 's off	colloquial, catch phrase
75 T*	what 's your problem	colloquial, catch phrase
85 T*	I will be [with you] [in a moment]]	standard, discoursal, stereotype
92 T	you right	colloquial, catch phrase
119 T	[[to hang around with]]]]	colloquial, idiom
150 T	what 's the story	colloquial, catch phrase
166 T	need I say more	colloquial, cliche
192 T	nothing like	colloquial, catch phrase
194 T	got away [with it]	colloquial, catch phrase
197 T	thank you	standard, discoursal, social formula
330 T	you 've got it	colloquial, catch phrase
398 S?	wait a sec	colloquial, catch phrase
477 T	just a sec	colloquial, catch phrase
524 T	[[how it goes]]	colloquial, catch phrase
532 T	in other words	standard, discoursal, structuring
562 T*	(I know) I know	standard, discoursal, gambit
577 T	are you [with this]	colloquial, catch phrase
639 T	same story	colloquial, cliche
687 T	we all do it	colloquial, cliche
709 T	no great drama	colloquial, catch phrase

The largest number of items classified as 'other' occurs in Lesson C1. This bears testimony to the input of lexical choice in realising interpersonal meaning. However, the lexical choice of items in Lesson C1 functions to realise a marginal position as opposed to one of dominance. Instead of shifting back and forth between everyday discourse and the bounded area of mathematical discourse, the students are firmly positioned outside the perimeter.

Table 7.27 Anaphoric attributes

Clause N^{o}/ Speaker	Classification	Anaphoric attribute
354 T	standard, variable expression	tricky
373 T	standard, variable expression	brilliant
528 T	standard, variable expression	too time consuming and fiddly
541 T	standard, variable expression	very hard
706 T	standard, variable expression	very important
716 T	standard, variable expression	straightforward

Anaphoric nouns do not feature as strategies for interpersonal meaning. One exception is "an obvious trap" (clause 782) which operates to downplay a perceived difficulty in the mathematical content. On the other hand, anaphoric attributes function covertly to understate the level of difficulty of the content as seen in Table 7.27.

Instances of grammatical metaphor realising interpersonal meaning do not occur in Lesson C1. Tense, phase and modality are congruently realised. This suggests that the oral discourse of Lesson C1 lacks sophistication with respect to interpersonal meaning as compared with Lesson A and B. As I demonstrate, this trend applies to other dimensions of meaning in Lesson C1.

7.232 Tenor

I believe that facets of the tenor relations of Lesson C1 point to a monofunctional tendency orientated towards interpersonal meaning to the detriment of experiential, logical and textual meaning. Further to this, I believe that the tenor relations function to undermine efforts made by the students to learn mathematics.

In Lesson C1, the prominence of interpersonal meaning functions to eclipse the other metafunctions of language. That is, the nature of the exchanges between the teacher and the students is largely the result of linguistic selections which are orientated towards realising interpersonal meaning. The surges of interpersonal meaning resulting from exclamatives, instances of reacting, dysphemisms and euphemisms, colloquialisms, amplification and ellipsis create a mountainous terrain of multiple peaks. In an effort to avoid falling into an abyss of chaotic tenor relations, the lesson consists of a series of bridges between these peaks of interpersonal meaning. The result is a dynamic interplay which is dominated by interpersonal concerns at the expense of others.

In Lesson A and B, group cohesion is founded on the shared social goal of learning mathematics. In Lesson C1 the goal of learning mathematics does not seem sufficient to maintain the tenor relations. If it were, the manipulative strategies of control exercised by the teacher would not be found. These covert strategies merit close examination.

A position of deference of both the teacher and the students is evident in linguistic patterns such as interpersonal metaphor between the SPEECH FUNCTION and MOOD, ellipsis and the covert orientation of lexical items. However, beyond this the power position of the teacher is firmly established through his role of primary knower and his initiation and closure of chains and strings. The differing forms of address for teachers and students reinforce this position. Although these patterns are common to each lesson, what is striking about Lesson C1 is the covert form of control exercised by the teacher. This form of control permeates each stage of the lesson to create a decisive line between the teacher and the students. However, in the global sense, significantly this pattern of control realised by the teacher to maintain his position ultimately realises deference. The power dominating position realised in Lesson A operates through interpersonal congruence. There is a directness in the interpersonal relations of Lesson A which is the antithesis of the covert quality of these relations in Lesson C1.

The teacher's power to control the students operates covertly through sarcasm. Although sarcasm is an effective strategy for the operation of power as demonstrated by the former Australian Prime Minister Paul Keating, it is nonetheless relatively ineffectual if operating in isolation. That is, Paul Keating has multiple linguistic resources for maintaining his position of dominance. For the students in Lesson C1, however, while they may learn to use sarcasm, in combination with their other linguistic resources as displayed in the oral discourse of the lesson, ultimately they occupy a position of deference in society.

In the *Oxford Companion to the English Language* , the role of sarcasm in the operation of power is acknowledged.

> **SARCASM**: [16c: from Latin *sarcasmus*, Greek *sarkasmos* tearing flesh, speaking bitterly]. A term in rhetoric and general use for sneeringly ironical remarks: ... Sarcasm serves to taunt and deflate. It often stems from resentful and embittered insecurity, but is also used by people in authority (such as teachers and army instructors) as a means of marking and maintaining that authority
>
> (McArthur, 1992, p. 887)

Significantly, interpersonal relations of unequal power are maintained at the cost of making individual students the object of ridicule in Lesson C1. Group cohesiveness is maintained through the operation of power through

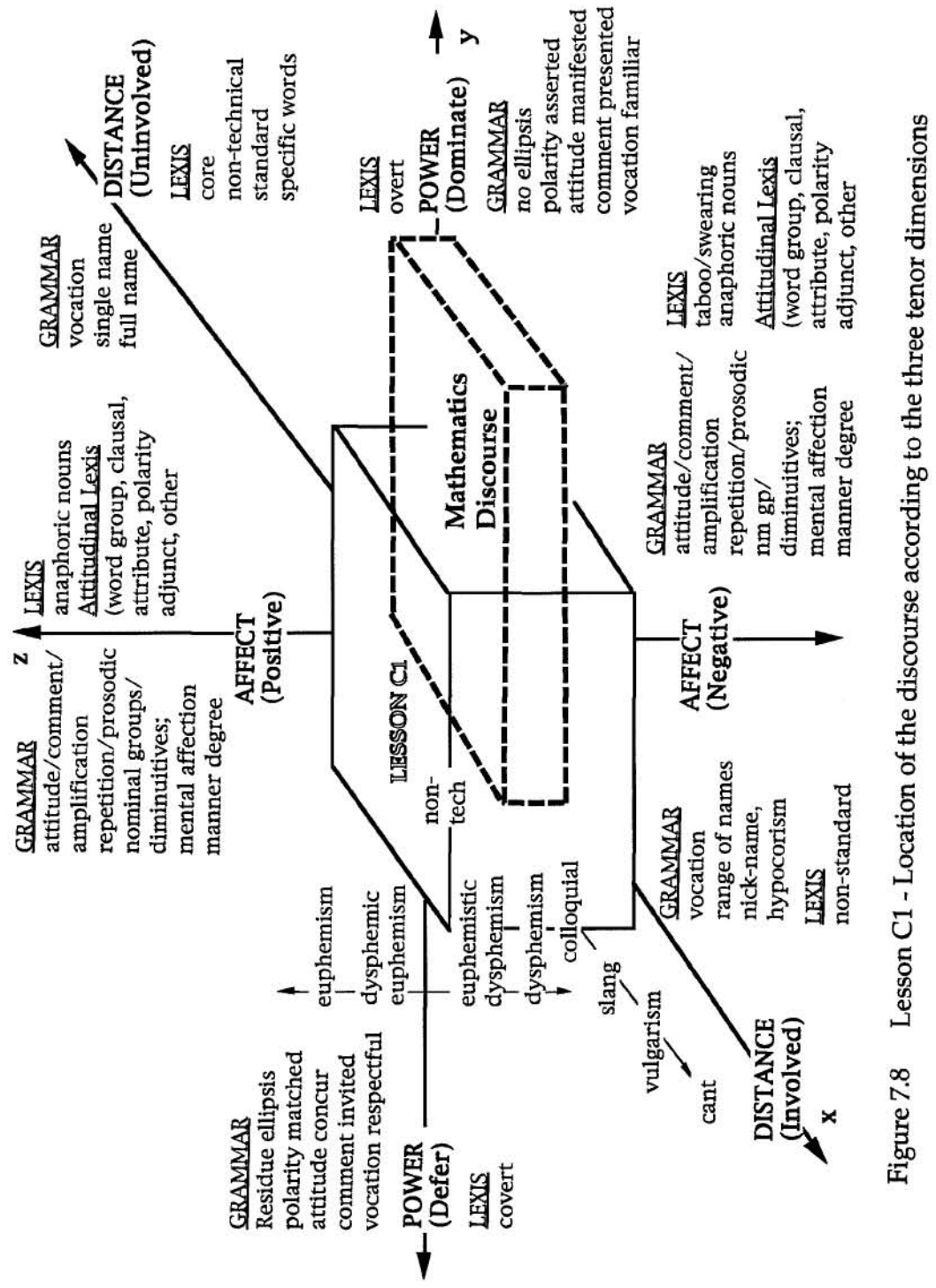


Figure 7.8 Lesson C1 - Location of the discourse according to the three tenor dimensions

fear. In addition to the humour introduced in these covert strategies, the teacher balances his techniques of control with the use of colloquial language. This operates in the reverse direction to create degrees of familiarity and solidarity. The realisation of affect and intimate contact means that the teacher is aligned with the students while at the same time maintaining a power differential.

The teacher's central concern is maintaining the interpersonal relations. His constant need to reaffirm his position of power and to staunch any uprising suggests that the social goal of learning mathematics is not enough to ensure group solidarity. Indeed, teacher comments work to undermine student confidence in learning mathematics. For example, the teacher sardonically says "it's very hard isn't it" (clause 541) after introducing the new content of the lesson. However, as I demonstrate in section 7.251, at least some of the students experience difficulty with the experiential meaning of this new content. As seen in this same section, I suggest that the reasons for these difficulties lie in the ambiguity and shifting functions of particular mathematical symbols together with the nature of the surrounding oral discourse.

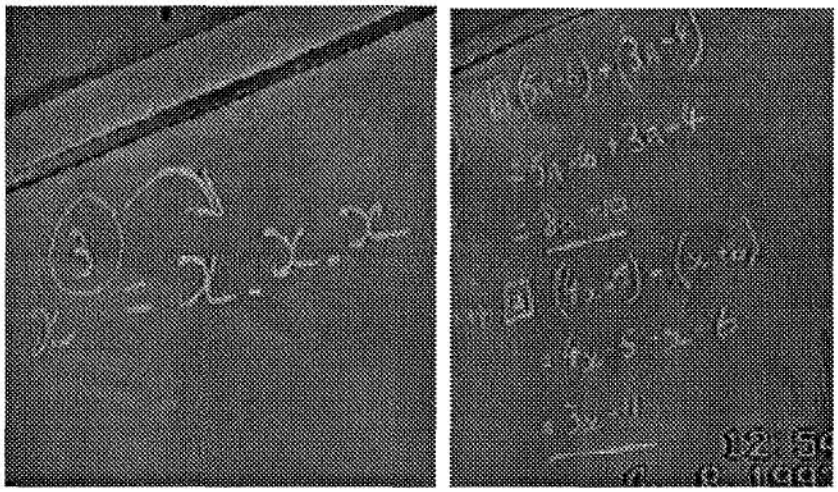
The differing social purpose of Lesson C1 has significant consequences. Firstly, the teacher is not primarily engaged in teaching mathematics and the students are not primarily engaged in learning mathematics. Secondly, the tenor relations mean that the majority of students learn to defer to the teacher and indeed to authority in general. The deferential position of the students realised in the oral discourse does not accord with the patterns of dominating relations found in mathematical discourse. A representation of the tenor relations of Lesson C1 compared with mathematical discourse is given in Figure 7.8.

7.233 The Mathematical Text

The views of the board text given in Scenes 7.1 to 7.6 below serve to illustrate general features of the visual display in Lesson C1. In Scene 7.1 it is evident that visual cues function to realise modal meaning. In the first frame the circling of the three in combination with the arrow directs the viewer's gaze. In the second frame the rectangular box enclosing the number of the

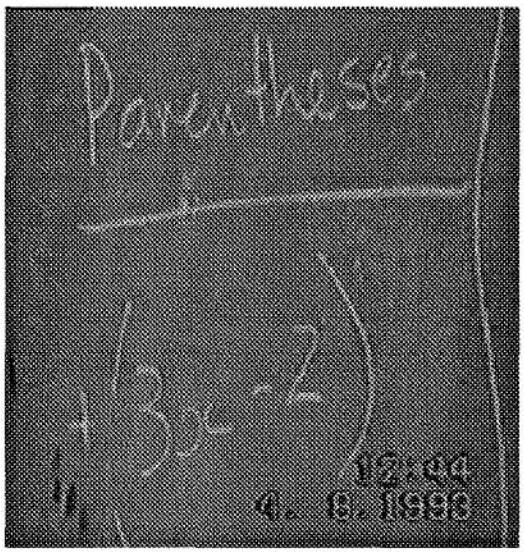
problem and the underlining of the solution similarly function in a modal capacity to make prominent these parts of the visual display.

Scene 7.1 The board text - View 1



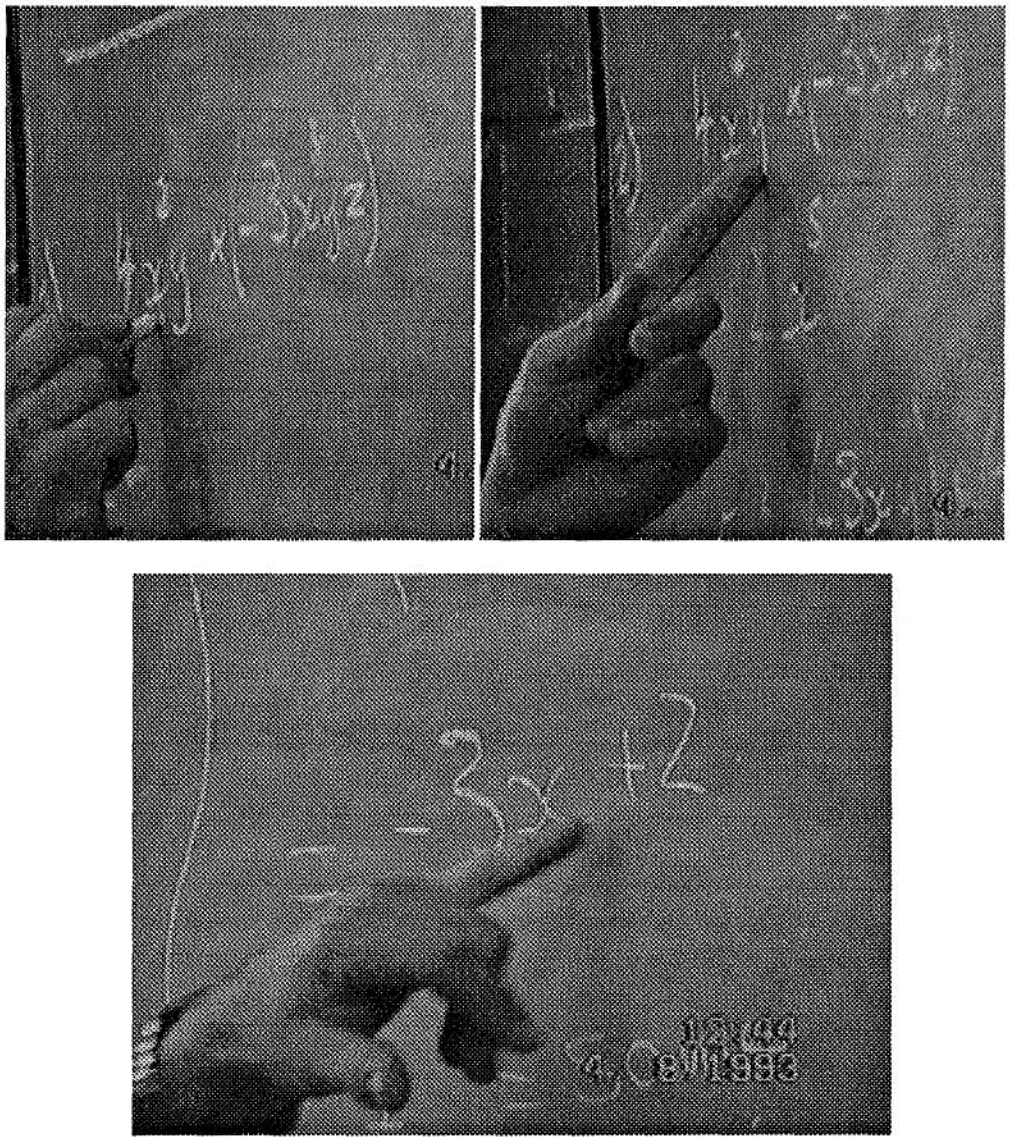
In Scene 7.2 it may be seen that the teacher compartmentalises sections of the board text with freehand lines. This is the same strategy used in Lesson B to highlight parts of the board text. The fingerprints on the blackboard in the bottom left hand corner of Scene 7.2 are evidence once again of the importance of gesture in realising interpersonal meaning. The role of gesture in realising command to focus on particular parts of the text is explicitly captured in the three frames of Scene 7.3 below.

Scene 7.2 The board text - View 2



The teacher directs attention with the chalk and through pointing his finger in the three frames given in Scene 7.3. There are, however, differing values of modality associated with the hand movements in the last two frames. In the first of these, the modality is high as the index finger is fully extended with the other fingers firmly clasped together. As with an arrow, the direction is unambiguously clear and there are no detractors. In the last frame, however, the modality is lower. The teacher points with his smallest finger while the spread of the other fingers serve to detract from the line of sight. As these preliminary observations suggest, a grammar of gesture needs to be developed if its role in constructing meaning is to be fully appreciated.

Scene 7.3 The board text - View 3

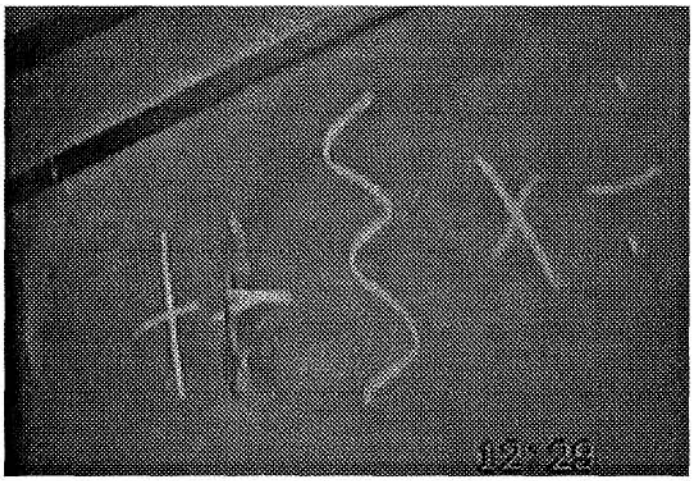


The view of the board text given in Scene 7.4 highlights a feature of the board text which will be further explored with respect to experiential meaning. In this display, the wavy line is prominent only through its size. The two groups of mathematical symbols, one for addition and subtraction and the other for multiplication and division, are thus separated. This board text is constructed in conjunction with the following oral discourse:

94 T // we have two separate sets of rules
95 T // we have one set of rules [for adding and taking away]
96 T // and that applies to algebra fractions numbers anything [[that you do [in mathematics]]]
97 T // you have one set separate set of rules [for algeb /ah/ [for adding and taking away]
98 T // and you have the other separate set of rules [for multiplying and dividing]

The significant feature of this visual display is the sole reliance on a non-generic visual cue of the wavy line to realise experiential meaning. This resembles other strategies depicted in Scene 7.5 below.

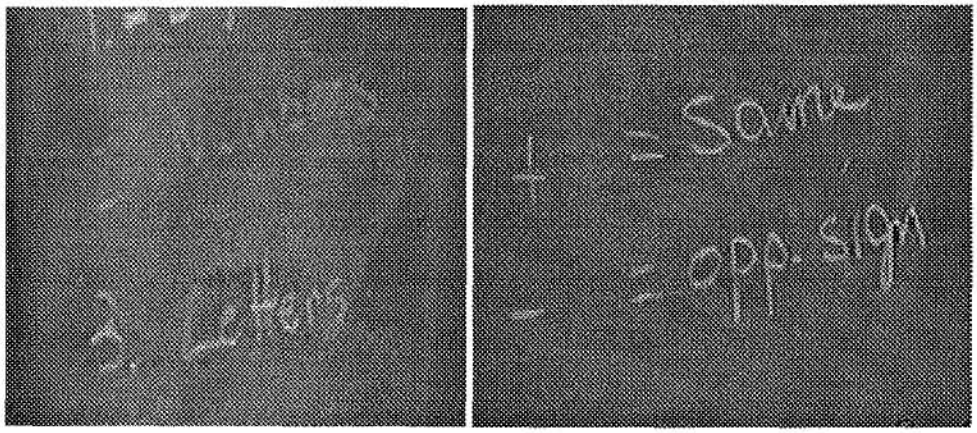
Scene 7.4 The board text - View 4



In the two frames of Scene 7.5, it may be seen that the strategy for encoding experiential and logical meaning is influenced by interpersonal considerations. For example, the teacher summarises in numbered point form the order in which the components of the symbolic terms are simplified as shown in the first frame. In the second frame, the teacher again summarises the experiential content in a non-generic abbreviated form. In this frame, it may be seen that the signs and words are spatially positioned so that the "=" functions modally to link the two. In essence, the

teacher distils particular aspects of the ideational content into a form that is modally accessible through visual cues.

Scene 7.5 The board text - View 5



Although not observable in these displays, colour operates in a modal capacity to realise interpersonal meaning. For example, in the first frame of Scene 7.5, each of the numbered elements is written in different coloured chalk. These colours match the colour of the corresponding components of the symbolic text. For example, the word "letters" and the variables in the symbolic text are both written with yellow chalk.

The complete board text is reproduced below in Figure 7.9. With the exceptions of #B, #C, #D and #E which are reports or 'storing information' genres, these texts are 'solving problem' genres consisting of the mathematical problem and the solution.

In the analyses of the board text, I focus on different genres to illustrate particular facets of the written texts produced in Lesson C1. At this stage, I should like to comment that while the mathematical problems and solutions realise generic forms, the parts of the board texts concerned with 'storing information' do not conform to generic specifications. That is, the notes on the board are hybrid forms of texts. As I discuss in subsequent sections, this has significant repercussions for the students who presumably are supposed to refer to these notes at a later date. In addition, these forms of notes mean that students are not being exposed to the genres of mathematics which are found, for instance, in mathematical textbooks.

#A

Simplify:

1) $3x^2 - 2x + x^2 - 4x$

$= 4x^2 - 6x$

2) $4x^2y \times (-3x^3yz)$

$= -\ 12x^5y^2z$

3) $5x^2 \times (-3xy) \times (-4x^2) \times (-4y^2) \times (-3)$

$= +240x^5y^3$

#B

$+\ \ -\ \ \sum\ \ x\ \ \div$

#C

1. - Signs
2. Numbers
3. Letters

#D

$x^3 = x.x.x$

#E

Parentheses

$+ (3x - 2)$
$= 3x - 2$

$- (3x - 2)$
$= - 3x + 2$

$\therefore$ + = same
- = opp. sign

#F

Exercise 2.2

Remove parentheses and simplify:

1. $(5a - 6) + (3a - 4)$
2. $(4x - 5) - (x + 6)$
3. $(7m + 6) - (3m - 5)$

#G

1. $(5a - 6) + (3a - 4)$

$= 5a - 6 + 3a - 4$

$= \underline{8a - 10}$

2. $(4x - 5) - (x + 6)$

$= 4x - 5 - x - 6$

$= \underline{3x - 11}$

3. $(7m + 6) - (3m - 5)$

$= 7m + 6 - 3m + 5$

$= \underline{4m + 11}$

#H

Add (5x +2) to (3x - 1)

(5x + 2) + (3x - 1)

= 5x + 2 + 3x - 1

= 8x + 1

Subtract 4x - 1 from 3x -3

(3x -3) - (4x - 1)

= 3x - 3 - 4x + 1

= - x - 2

#I

(3x -3) - (4x - 1)

= 3x - 3 - 4x + 1

= -x - 2

(5x - 7y) + (4x -11y)

= 5x - 7y + (4x

Figure 7.9 The board text

As may be seen, the text is construed through the codeployment of language and mathematical symbolism. Interpersonally, the linguistic components of this text realise commands as in "simplify", "Remove parentheses and simplify" and "Add (5x +2) to (3x - 1)" and "Subtract 4x-2 from 3x-3". These imperative commands realise dominating relations through modal congruence. We may note that this disaccords with the interpersonal positioning of the students.

The teacher uses linguistic selections to summarise the methods involved in simplification of the algebraic expressions. However, these are expressed as nominal groups as, for example, in "signs", "numbers" and "letters", "parentheses" and "same". These point-form summaries utilise visual cues and spatial position to realise interpersonal meaning. This means that there is no coherent visual linguistic text which accompanies the mathematical symbolic text. Although this may be adequate in the context of the accompanying oral discourse of Lesson C1, it would be difficult to revisit this text. This point is discussed further in the examination of the experiential meaning in section 7.253.

The symbolic text consists of statements realised by non-modalised declaratives. The text thus realises power dominating relations which are constitutive of mathematical discourse. As previously mentioned, modal prominence is achieved through visual cues of circles, boxes, arrows, underlining and although not evident in this display, freehand lines which compartmentalise the blackboard.

An interesting aspect of the board text is that the symbolic text consisting of the simplification of the algebraic expressions accords with generic specifications. As a consequence, power dominating relations are realised. However, the parts of the board text which summarise the methods and logical foundations for the simplification of the expressions do not adhere to generic forms. Explanations in the form of definitions, properties and axioms are not given. The interpersonal meaning of this non-generic text is less dominating. Although this aligns with the interpersonal position of the students with its emphasis on interpersonal meaning as realised by visual cues, as will be seen, there are significant repercussions with respect to experiential and logical meaning.

Some of the general features of the exercise sheet previously displayed in Figure 7.4 deserve special mention as the format and style is typical of mathematics worksheets and textbook examples.

The sets of exercises are clearly demarcated through the modal prominence of the heading for each exercise. Attention is focussed through font size, bold type and capitalised letters. Similarly, the heading "REMOVING BRACKETS" is emphasised by an even larger font size. Attention is drawn

to the type example and the solution through the italicised font. As will be seen, however, the non-generic textual format of the solution on the worksheet differs from the one that the teacher gives in the board examples. That is, each step in simplification is placed directly underneath the original algebraic expression. In the example given on the worksheet, however, the first step in the simplification appears on the same line as the original algebraic expression.

The interpersonal function of the language component of the text is to realise commands as in "Express the following algebraic expressions in their simplest form". The ideational meaning of this linguistic component realises the nature of the processes which are to be performed. The clear textual organisation of the exercises operates through spatial arrangement of the columns, numbers and algebraic expressions. In particular, the numbering of each exercise is modally prominent through spatial position.

The text realises power dominating relations. Interestingly enough, this is somewhat dismantled though the freehand word "Ruth" which appears next to each exercise number. It is highly doubtful that such a selection would appear in handouts of class exercises at School A.

7.24 Textual Meaning

7.241 General Lexicogrammatical Patterns, IDENTIFICATION and Textual Metaphor

The nature of the Theme selections of Lesson C1 is summarised in Table 7.28. While the low incidence of marked Themes is comparable to that found in Lesson A, Lesson C1 has a relatively low percentage of marked Themes. As a consequence of the field being algebraic expressions, Lesson C1 has the highest incidence of rankshifted Themes together with Lesson B. However, these selections are minimal in terms of the total number of Themes. Although comparable with Lesson C2, the highest incidence of ellipsed Themes is found in Lesson C1. While significantly higher, the percentage of minor clauses with no Theme is second to Lesson A. The incidence of dependent Themes realised through the foregrounding of the secondary clause in hypotactic clause complex relations is highest in Lesson C1, although the variation across all lessons falls within a narrow range.

Table 7.28 Classification and components of Theme selections

	Total	Percentage
Theme	733	100
CLASSIFICATION OF THEME		
Unmarked	431	58.8
Marked	34	4.6
Dependent	41	5.6
Embedded	11	1.5
Ellipsed	138	18.8
No theme (minor clause)	77	10.5
Unknown	2	0.3
NATURE OF THEME		
No Thematic components		
Ellipsed topic	128	17.5
Minor clause or Non-finite dependent clause	53	7.2
Single Theme		
Ideational only	339	46.2
Multiple Theme	211	28.8
1. Ideational component	(177)	
Ideational/Textual	132	
Ideational/Textualx2	19	
Ideational/Textualx3	2	
Ideational/Interpersonal	18	
Ideational/Textual/Interpersonal	5	
Ideational/Textualx2/Interpersonal	1	
2. No Ideational Component		
a. Ellipsed Topic	(10)	
Textual	9	
Interpersonal	1	
b. Minor /Non-Finite Dependent Clauses	(24)	
Textual	12	
Interpersonal	9	
Interpersonalx2	1	
Textual/Interpersonal	2	

Generally speaking, the colloquial nature of the discourse realised through lexical choice extends to thematic patterns in Lesson C1. In nearly one fifth of all clauses, the Theme is ellipsed. In addition, few marked Themes are realised. In general, the textual organisation of Lesson C1 is not as sophisticated as that of Lesson A which tends to be more aligned with written discourse.

Closer examination of the components of the Theme as given in Table 7.28 above reveals that Lesson C1 has the highest proportion of ellipsed topics and single Themes and the lowest proportion of multiple Themes. Significantly, the proportion of multiple Themes of Lesson C1 and C2 is well below that found in Lesson A and B. The textual organisation of the pedagogical discourse of these working class students is simpler than that found in Lessons A and B. Further to this, there are two hundred and six textual components or an average of 27.5% of clauses in Lesson C1 contain a textual element. This is the lowest percentage of the four lessons and reflects the disjointed nature of Lesson C1.

In Lesson C1 there are thirty eight interpersonal components in the Theme. This means that an average 5.2% of clauses contain an interpersonal element. This percentage is lower than that found in Lesson A and Lesson B. It appears that despite the prominence of interpersonal meaning realised in Lesson C1, it is not a product of Thematic foregrounding of Mood Adjuncts, Vocatives or Finites. Rather, the interpersonal meaning operates covertly through lexical choice and interpersonal incongruence.

The nature of the field of the topic in the Theme is listed below in Table 7.29. The frequency of the teacher and students versus mathematical content featuring as the point of departure for the message is approximately equivalent. With respect to the interlocutors as the topic, however, the students are selected proportionally nearly three times more often than the teacher. The lowest incidence of both the teacher and the students as a collective group forming the topic is found in Lesson C1. This supports the trends of interpersonal meaning of Lesson C1. That is, despite the colloquial nature of the interactions, the line between the teacher and students is firmly drawn.

Significantly, the ratio of 'other' Themes is greatest in Lesson C1. Nearly one fifth of the total number of Themes do not concern the teacher, the students, the mathematics or the student work. This pattern is reflected in the wide range of microgenres realised in Lesson C1. It also accords with the notion that the major goal of this lesson is not directed towards teaching and learning mathematics

Table 7.29 Field of theme

FIELD	Total	Percentage (1 d.p.)
	516	100
Teacher	39	7.6
Students	112	21.7
Teacher and students	28	5.4
TOTAL	179	34.7
Mathematical lexical item	50	9.7
Mathematics (WH-item)	42	8.1
Mathematics (TH-item)	23	4.5
Maths (pronoun)	25	4.8
Related to Mathematical classwork	44	8.5
TOTAL	184	35.7
Student work	10	1.9
Action	44	8.5
Other	99	19.2

The incidence of rankshifted clausal elements in Lesson C1 is the highest found in any lesson. This is a result of the field of the lesson which is algebraic expressions. However, this incidence of clausal rankshift is the direct result of the teacher calling out the answers to the fifteen homework questions (clause 421) As will be seen in the analysis of the reference chains, the provision of linguistic versions of the symbolic participants is limited at other stages of the lesson.

Table 7.30 Clausal and phrasal rankshift

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	731	100
Rankshifted Clausal Element (Total)	100	13.7
Rankshifted Clause and Phrase Elements	33	4.5
Rankshifted Phrase Only	106	14.5

If the student clauses are examined for clausal rankshift as given in Table 7.31, only seven clauses contain such an element. With the exception of Lesson C2, this is the lowest frequency found in the lessons.

Along with Lesson B, the low percentage of rankshifted phrases as shown in Table 7.30 is a function of the field of the discourse and the lack of mathematical diagrammatic or graphical display.

Table 7.31 Clausal and phrasal rankshift: Teacher and student contributions

	Teacher		Student	
	Total	% (1 d.p.)	Total	% (1 d.p.)
CLASSIFIED CLAUSES (Total 731)	591	80.8	140	19.2
RELATIVE PERCENTAGE	591	100	140	100
Rankshifted Clausal Element - Total	93	15.7	7	5.0
Rankshifted Clause and Phrase Elements	31	5.2	2	1.4
Rankshifted Phrase Only	96	16.2	10	7.1

An example of the major reference chains is given in Figure 7.10. This particular excerpt was selected as the field concerns the introduction of the new content of the lesson.

As for each of the excerpts analysed in this study, the reference patterns concern the intertwining of chains realised in the oral and visual discourse. Although not indicated with arrows, the references are anaphoric with respect to the preceding discourse or exophoric with respect to contextual factors.

The major participant in this excerpt is the students as realised by "you". This would usually have the effect of increasing the depth of the rankshifted mathematical participants. However, these reference chains do not contain linguistic versions of the participants of the symbolic text even with the visual display playing a constitutive role. Instead, the teacher simplifies the reference patterns through selection of items such as "it", "everything", "thing", "what" and "your next line". The teacher's lack of verbalised mathematical participants greatly simplifies the lexicogrammatical complexity of the oral discourse. Although this does not occur at all stages of

CONSTITUENT MODE: Aural (linguistic)
ANCILLIARY MODE: Visual (symbolic)

525 T // if you have just a plus or a minus sign [in front of it]

526 T // you really have got an invisible one

527 T // and you are really multiplying everything [in there] [by the invisible one]

528 T // but it is too time consuming and fiddly [[to do that]]

529 T // [with the invisible one] it 's much easier [[to use a short cut rule]]

530 T // and the short cut rule is [[that if you have a plus sign [outside a bracket]]]

CONSTITUTIVE MODE: Visual (gesture)
The teacher points to "+ (3x - 2) "

CONSTITUENT MODE: Visual(symbolic)

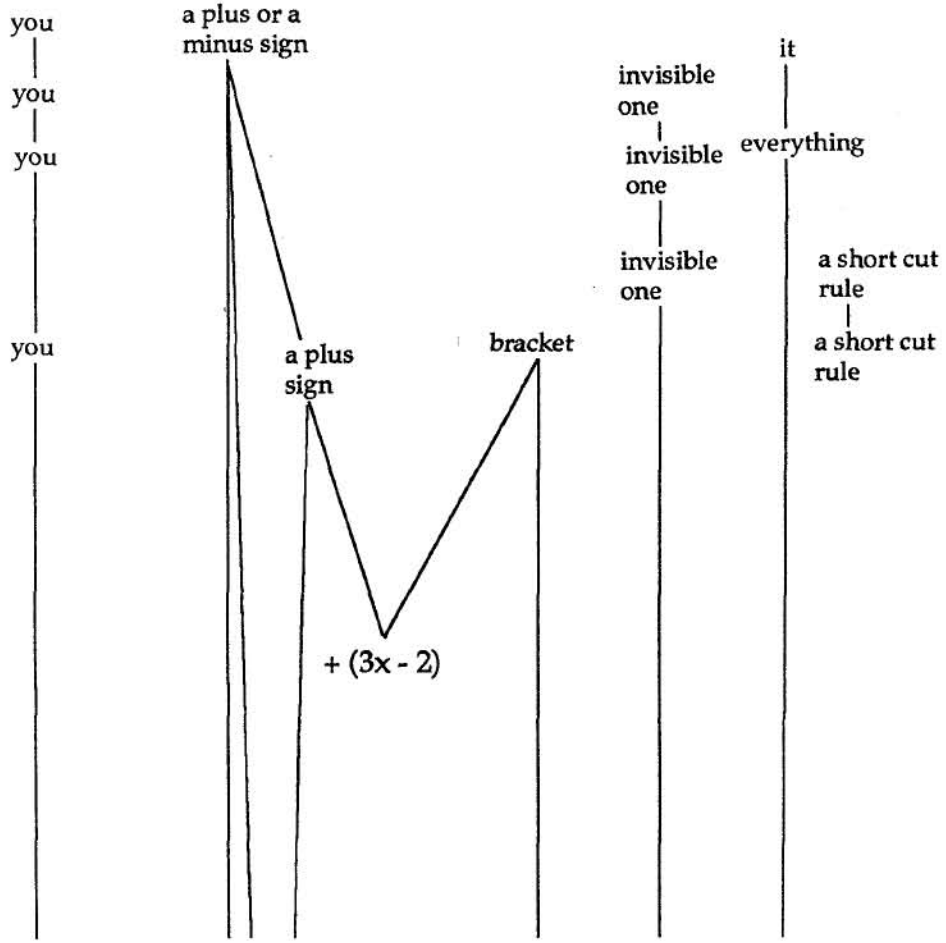
Parentheses

+ (3x - 2)
= 3x - 2

- (3x - 2)

= - 3x + 2

∴ + = same
- = opp sign



<u>CONSTITUENT MODE</u>: Aural (linguistic)
<u>ANCILLIARY MODE</u>: Visual (symbolic)

531 T // your result is [[exactly what 's [in the bracket]]]

<u>CONSTITUTIVE MODE: Visual (gesture)</u>

teacher points to " ∴ + = same "

<u>CONSTITUENT MODE</u>: Visual(symbolic)

Parentheses

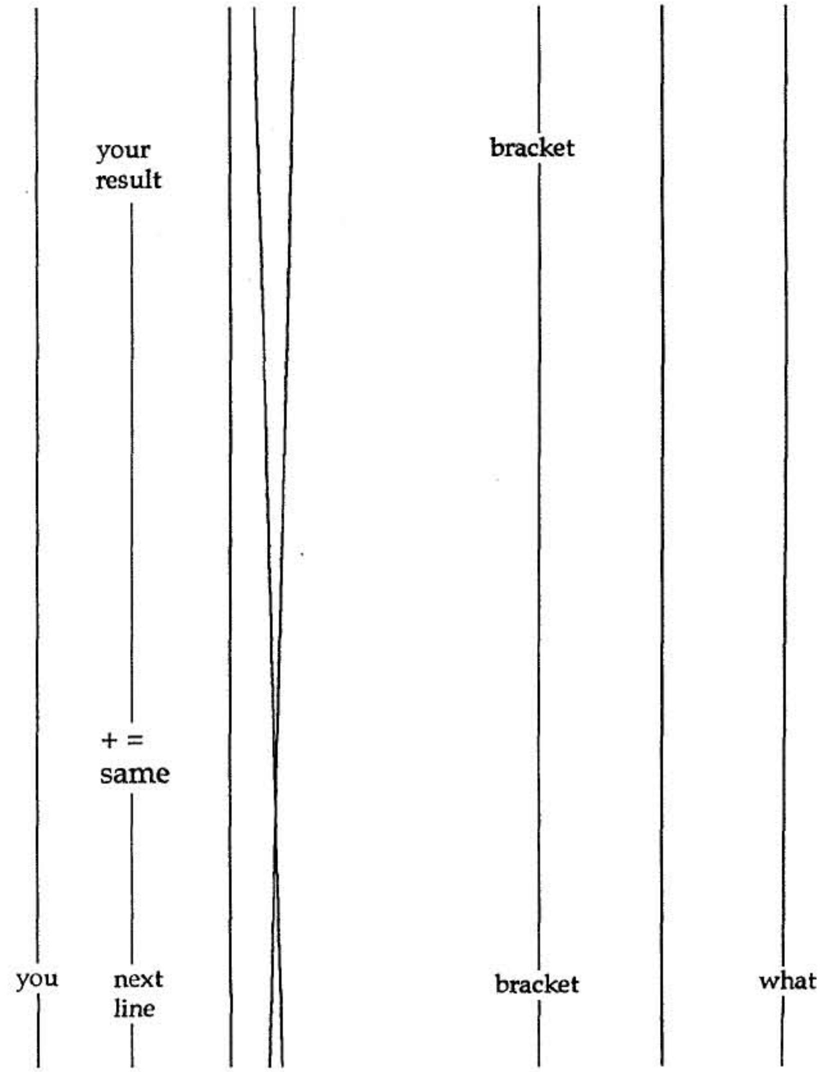
+ (3x - 2)
= 3x - 2

- (3x - 2)
= - 3x + 2

∴ + = same
- = opp sign

<u>CONSTITUENT MODE</u>: Aural (linguistic)
<u>ANCILLIARY MODE</u>: Visual (symbolic)

532 T // in other words you just copy [[what you had [in the bracket]]]down [as your next line]



CONSTITUTIVE MODE: Visual (gesture)

teacher points to = 3x -2

CONSTITUENT MODE: Visual(symbolic)

Parentheses

$+ (3x - 2)$
$= 3x - 2$

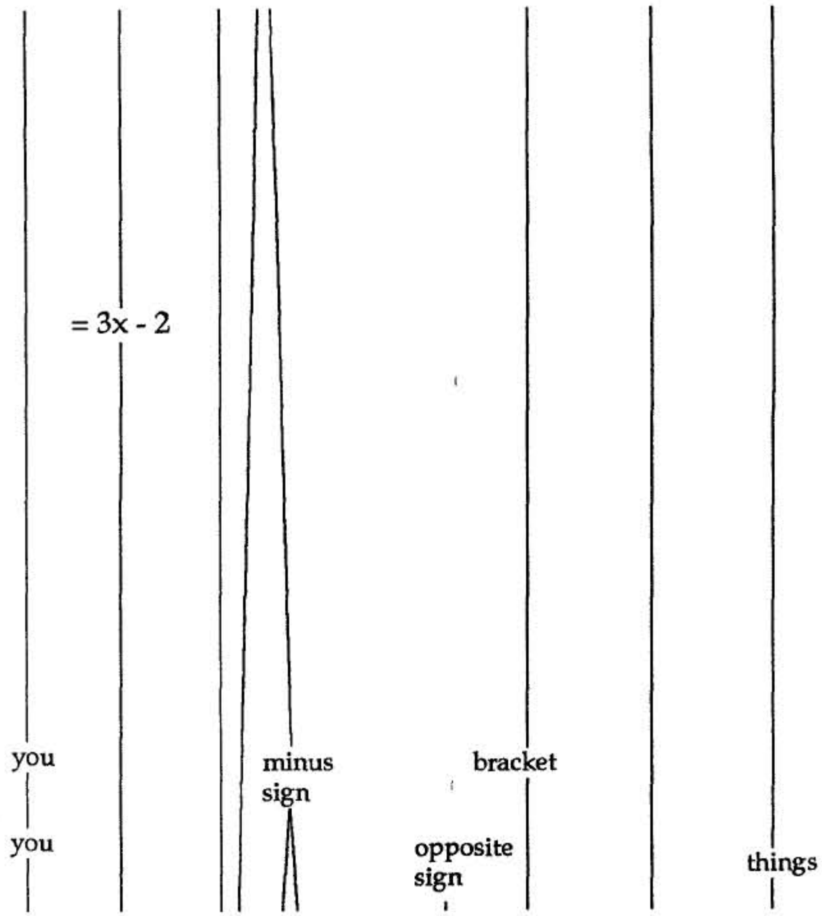
$- (3x - 2)$
$= - 3x + 2$

$\therefore$ **+ = same**
- = opp sign

CONSTITUENT MODE: Aural (linguistic)
ANCILLIARY MODE: Visual (symbolic)

533 T // if you have a minus sign [outside the bracket]

534 T // then you copy the opposite sign [to the things]



CONSTITUTIVE MODE: Visual (gesture)

teacher points to the signs in - (3x - 2) = -3x +2

CONSTITUENT MODE: Visual(symbolic)

Parentheses

+ (3x - 2)
= 3x - 2

- (3x - 2)
= - 3x + 2

∴ + = same
- = opp sign

CONSTITUENT MODE: Aural (linguistic)

535 T // the numbers and the letters don't change
536 T // cause when you multiply [by one]
537 T // you don't change anything
538 T // so [[all you do]] is [[you copy the numbers and letters [[just as theyare]]]]
539 T // but the signs reverse
540 T // any questions [on that] then
541 T // it 's very hard isn't it
542 Ss <indistinct>

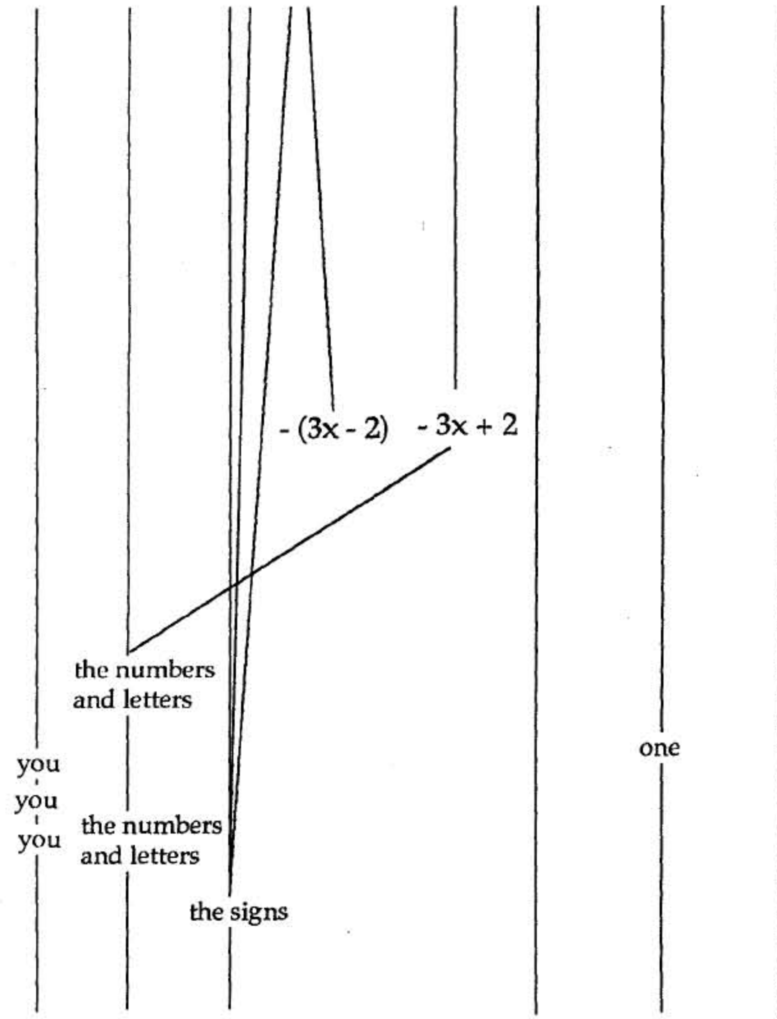


Figure 7.10 An example of the major reference chains

the discourse, it nevertheless is a significant feature of the general reference patterns. As I discuss in Chapter 9 in section 9.4, "Social Class and Mathematics", these examples of lexical non-specificity are characteristic of Bernstein's (1971; 1990) formulations of a restricted code.

The nature of the reference selections and the restricted code means that the role of gesture and other contextual factors play an even more important role in realising textual meaning than previously indicated in Lessons A and B. Unless the students are watching closely, they are not in a position to track the participants. That is, the students are not exposed to tracking the participants through cojoining and splitting of linguistic participant configurations. If they are to track the participants, it is through visual as opposed to oral cues. Significantly, the teacher and the students are not replicating the textual organisation which is specific to mathematical oral discourse. The result is discourse which mirrors the textual organisation of everyday meaning as opposed to that of mathematical meaning.

The teacher also uses non-technical mathematics register items to refer to participants. These include the "letters" and "numbers" for the variables and constants respectively and items such as "the invisible one". These selections are discussed with respect to experiential meaning in section 7.251.

7.242 Mode

As for each of the other lessons, the microgenres of the lessons involve multiple shifts between oral and visual modes as the constitutive and ancillary codes. There is, however, a wider range of microgenres that are realised solely through an aural mode. These include Student Interruptions, Teacher Disciplinary Interruption, Teacher Narrative, Teacher Sideplay, Outside Interruption, Liminal Activities and Student-Student Private Interactions. Nevertheless, when the field is the mathematical content, the modes are both aural and visual and the codes are language, mathematical symbolism and gesture.

Given the observations concerning the reference chains in the oral discourse and the visual board text, it appears that the visual mode may play a more constitutive role than in other lessons. The oral discourse lacks the textual organisation constitutive of mathematical pedagogical discourse. Instead,

visual cues in the form of gesture organise the oral discourse as metadiscourse for the mathematical symbolic text.

7.243 The Mathematical Text

The textual organisation of the visual text is examined through the participant chains displayed in Figures 7.11, 7.12 and 7.13 below. We may note that as a feature of the grammar of mathematical symbolism the spatial arrangement of the symbolic statements operates as an aid in tracking participants. Each new statement with its new participant configurations is placed underneath the previous one. As indicated, the presenting reference is exophoric with respect to the homework sheet in Figure 7.13 while the presuming reference is anaphoric in each of the three examples.

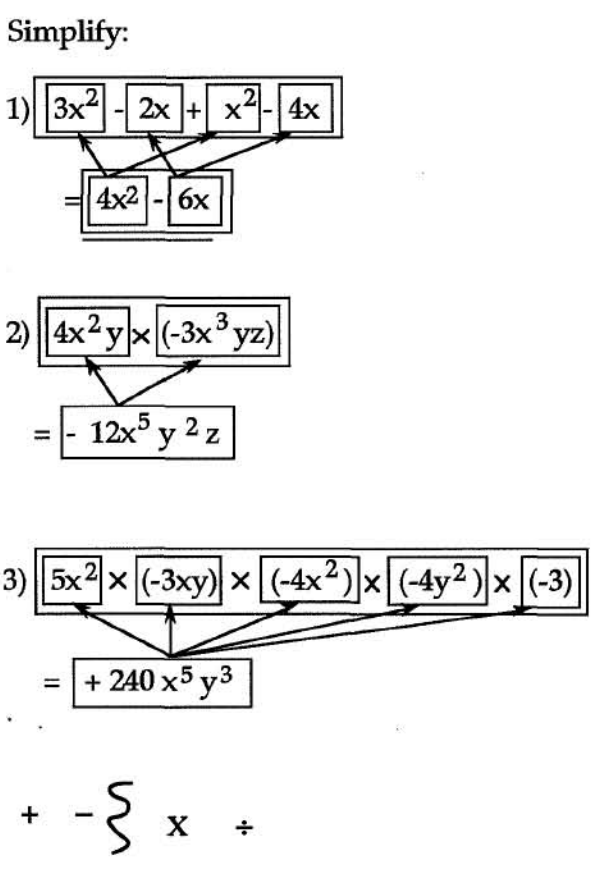


Figure 7.11 Major reference chains in the symbolic text

In Figure 7.11, as indicated, the participants are realised as rankshifted elements. With respect to the command to "simplify", tracking involves locating the appropriate participants that recombine to form one participant. It is interesting to note that the participants of the linguistic text, "signs", "numbers" and "letters", are realised respectively as components of the participant structures in the symbolic text. This is further explored in section 7.253 dealing with the experiential meaning of this text.

The reference chains in Figure 7.12 below are particularly revealing in that the changing status of different components of the symbolic text may be demonstrated. That is, the symbols "+" and "-" congruently realise the Operative process of addition and subtraction respectively. However, in the board text below, the "+" and "-" appear as "+ (3x - 2)" and "- (3x - 2)". It becomes apparent that given the syntagmatic structure of these algebraic expressions, the "+" and "-" do not realise the processes of addition and subtraction, for indeed if they do, the participants to which (3x - 2) is being added to or subtracted from are absent.

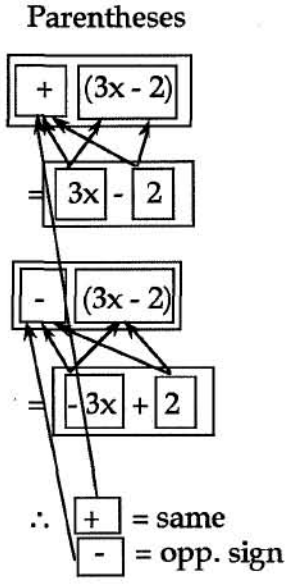


Figure 7.12 Major reference chains in the symbolic text

As indicated by the reference chains in Figure 7.12, the presumption that in this particular case the "+" and "-" function as participants is reinforced by the statement "+ = same" and "- = opp. sign". The latter hybrid statement

construed through selections from symbolic and linguistic codes is the subject of further discussion with respect to experiential meaning in section 7.253.

The new status of the "+" and "-" as participants is apparent in the following congruent realisations of "+ (3x - 2)" and "- (3x - 2)".

$$+ (3x - 2) = (+1) \times (3x - 2)$$
$$- (3x - 2) = (- 1) \times (3x - 2)$$

That is, the grammar of mathematical symbolism allows for ellipsis of both the symbol for "1" and the symbol for multiplication. It is clear from the oral discourse surrounding the construction of this symbolic text, that this is the manner in which the symbolic text is to be read. The teacher explicitly repeats the participant "the invisible one" (clause 526, 527 and 529) and its configuration with the process of multiplication. The teacher does not, however, explicitly realise this reading in the visual text.

In the symbolic text, the nuclear configurations implicitly involve therefore the process of multiplication between the participants "+1" , "-1" and "(3x-2)". In this case, as "positive one" and "negative one", the linguistic translations of "+" and the "-" function as Classifiers in the nominal group. The "+" and the "-" in the symbolic text have a similar function. As the equivalent of the Thing in the symbolic text, the "1" is ellipsed to leave the "+" and "-" to function as Classifiers in the participant structure. In an analogous manner, the "-" is read as "negative three" in "$(-3x^3yz)$" in the second example in Figure 7.11 above.

To clarify, in the example which the teacher uses for demonstration purposes, the statements "0 + (3x - 2)" and "0 - (3x - 2)" give identical results with the difference being that the symbols "+" and "-" congruently realise the process of addition and subtraction respectively.

Significantly, from these observations it is apparent that the same mathematical symbol may have different functions in terms of experiential meaning. That is, the grammar of mathematical symbolism allows for functional shifts which are marked only by the position of the symbol in the syntagmatic chain and the available paradigmatic options. As will be seen in section 7.251, the context of the situation as construed linguistically is

ambiguous as to the function of the "+" and "-". In Lesson C1, this leaves the context of the situation as construed symbolically as the sole means of interpretation of the function of these symbols.

Although the grammar of the English language allows for similar shifts in the function of elements, in most cases the function is marked by the nature of the word group. For example, apart from the introduction of new entities, grammatical metaphor in language is marked by the nature of the word group. For instance, a process is realised by a verbal group as in the case of 'transform' while a participant is realised by a nominal group 'transformation'. In other cases, the function of a range of linguistic elements is dependent on the position in the syntagmatic chain and paradigmatic options as in the case for "+" and "-" above. For example, "mean" can function to realise a process, participant or Classifier. However, confusion is contained in language since if there is ambiguity in the nature of the word group or the experiential function of a linguistic element, the context of the situation and cues such as those provided through the systems of tense and Deixis aid interpretation. However, in mathematical symbolism as demonstrated in the case above, these cues are not available. As I demonstrate in section 7.251, the context of the situation as linguistically construed is ambiguous. Interpretation of the function of "+" and "-" is based solely on the syntagmatic structure of the mathematical statement and a knowledge of the paradigmatic options.

The import of these observations becomes apparent in the analysis of the experiential meaning in section 7.251. In particular, I suggest that the discrepancies in the functions of "+" and "-" in the symbolic text and the surrounding discourse contribute to student difficulties in understanding the experiential meaning of the new content of the lesson.

The reference chains given in Figure 7.13 below are typical of those found in mathematical texts. After the participants are initially presented in the question, in turn each is repeated or configured directly underneath. The command to "remove brackets and simplify" results in the splitting and subsequent cojoining of participant configurations as illustrated by the reference patterns below.

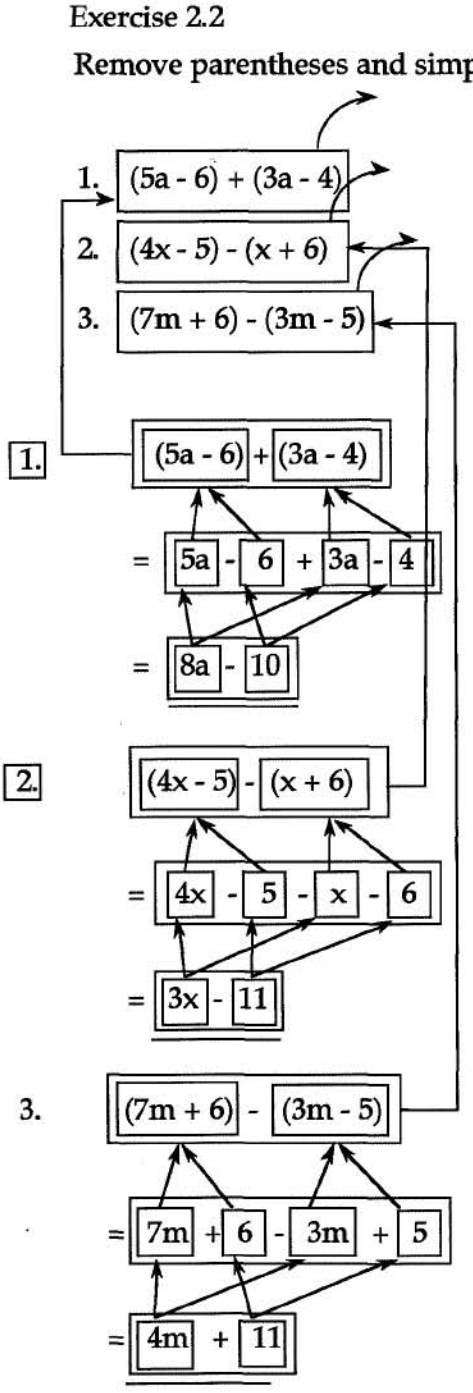


Figure 7.13 Major reference chains in the symbolic text

7.25 Experiential Meaning

7.251 General Lexicogrammatical Patterns, IDEATION and Experiential Metaphor

A summary of the process types from the system of TRANSITIVITY is given in Table 7.32.

Table 7.32 TRANSITIVITY: Process selections

	Major Clauses		Rankshifted Clauses		Overall Totals	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
Processes	574	100	141	100	715	100
MATERIAL	147	25.6	35	24.8	182	25.5
MENTAL	68	11.8	16	11.3	84	11.7
Cognition	34					
Perception	15		15			
Affection	19		1			
RELATIONAL - ATTRIBUTIVE	179	31.2	22	15.6	201	28.1
Intensive	96		10			
Circumstantial	19		8			
Possessive	64		4			
RELATIONAL - IDENTIFYING	95	16.6	2	1.4	97	13.6
Intensive	95		2			
Circumstantial	0		0			
Possessive	0		0			
OPERATIVE	22	3.8	53	37.6	75	10.5
VERBAL	28	4.9	9	6.4	37	5.2
BEHAVIOURAL	17	3.0	3	2.1	20	2.8
EXISTENTIAL	18	3.1	1	0.7	19	2.7

The trends associated with process types across lessons may be briefly summarised as follows. In Lesson A and C1, Relational Attributive processes are most common. The incidence of these processes is closely followed by Material processes. In Lesson B and C2, the reverse trend is found. In each case, however, the difference is minimal. As with Lesson B,

in Lesson C1 the next most common process type is Relational Identifying. However, in Lesson A and Lesson C2 Mental processes feature as the third most frequently occurring process type. The most significant difference is the lack of processes realising Cognition in Lesson C1. As for each lesson, the percentage of rankshifted Operative processes is significant.

The above observations indicate that oral mathematical pedagogical discourse is primarily concerned with processes of 'being', 'doing' and 'thinking'.

The highest incidence of 'effective' Voice is found in Lesson C1. That is, in this lesson there are more instances where an Agent makes or causes something to happen. This may be a function of the wide ranging fields realised in Lesson C1. Nevertheless, the Voice of the majority of clauses is 'middle' involving a Medium as seen in Table 7.33.

Table 7.33 Voice

	Ranking Clauses	Percent-age	Rank-shifted	Percent-age	Total	Percent-age
CLASSIFIED CLAUSES	532	100	137	100	669	100
EFFECTIVE 1. Active Agent Ellipsed Agent 2. Passive	128 127 121 6 1	24.1	3 2 2 1 0	2.2	131	19.6
MIDDLE (Active) Medium Ellipsed Medium	326 315 11	61.3	113 112 1	82.5	439	65.6
3. NO VOICE	77	14.5	21	15.3	98	14.6

Very few processes are realised metaphorically in Lesson C1, especially as compared with Lesson A. These are almost exclusively Mental processes such as "collecting" (clause 149 for example), "simplifying" (clause 164 for example), and "counting" which congruently realise Material processes and metaphorically realise processes of Cognition. Interestingly, although Operative processes are congruently realised, the lexical items are commonly a non-technical term as will be seen below in the analysis of the mathematical register items.

Table 7.34 Metaphorical processes

	Major Clauses		Rankshifted Clauses		Overall Totals	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
Processes	21	100	5	100	26	100
MENTAL	20	95.2	5		25	96.2
Cognition Perception Affection	20		5			
RELATIONAL - ATTRIBUTIVE						
Intensive Circumstantial Possessive	1	4.8			1	3.8

Examples of grammatical metaphor realising experiential meaning in Lesson C1 are listed below in Table 7.35.

Table 7.35 Grammatical metaphor and experiential meaning

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause: **EXPERIENTIAL**	
process ----->	**entity**
	1. 'Thing 'in nominal group
operate proceed concentrate differ	202 T // **second operation** 584 T // and you just follow **your collecting like terms procedure** 622 T // can we have quiet and **concentration** [for here] now 752 S2* // does it make **any difference**
	2. 'Thing' in propositional phrase
subtract	784 T // so an obvious trap is [[[[that [with **subtracts**] we have to remember]] to swing them around]]

process ----->	quality
multiply **divide**	**1. Modifier in nominal group** 169 T // that **multiplication sign** or a **division sign** changes the rules 100 T // both of them are **hitting games** [[involving a small ball]] 584 T // and you just follow **your collecting like terms procedure** **2. Modifier in nominal group of prepositional phrase** 170 T // there are three steps [to **the multiplication division situation**] 248 T // how many of that letter there are [in **a multiplication chain**] 292 T // because things are separated [by **an addition or a subtraction sign**] 606 T // that 's the effect [of **the minus sign**] 719 T // what happens [in **the subtract scenario**]

Experiential meaning tends to be congruently realised in the oral discourse of Lesson C1. Exceptions include shifts from processes to entities and qualities. In cases like "your collecting like terms procedure" (clause 584) both of these shifts are realised. Significantly, in this example and others such as "with subtracts" (clause 784), "to the multiplication division situation" (clause 170), "in a multiplication chain" (clause 284) and "in the subtract scenario", the terms are not mathematical technical terms. On the contrary, the terms are either non-technical or jargon terms. As seen below in Table 7.36, these types of expressions tend to dominate the discourse of Lesson C1.

While comparable to Lesson C2, over one third of all mathematical register items in Lesson C1 are non-technical as may be seen in Table 7.36. In addition, the high incidence of jargon terms means that just over half of all mathematical register items are technical terms. This may be compared to Lesson A and Lesson B respectively where 82.5% and 72.5% of all mathematical register items are technical terms. This indicates that the discourse of Lesson C1 deviates from the formal discourse of mathematics. In particular, selections such as "letters" and "numbers" for 'variables' and 'constants' also appear in the visual text.

Table 7.36 Classification of mathematical register items

	Total	Percentage (1 d.p.)
CLASSIFICATION	316	
Technical	163	51.6
Jargon	45	14.2
Non-technical	107	33.9
ELEMENTS	330*	
Clausal	42	12.7
Nominal Group Thing ellipsed Thing Deictic Epithet Numerative Classifier Qualifier	204 186 18 111 12 37 63 19	61.8
Verbal Group Event Finite Polarity Auxiliary Phrase Event Finite Polarity Auxiliary	32 31 31 7 1 1 1 1	9.7
Prepositional Group Phrase	45 46	13.6
Adverbial	0	0.0
Attribute	7	2.1
Other	0	0.0

Lesson C1 contains multiple educational register items as seen in Table 7.37 below. These include lexical items such as "good effort" (clause 57) and "correction time" (clause 89) and "put your hand up" (clause 651). Significantly other items from diverse fields such as gambling, medicine and film also occur. These are respectively "I'll lay odds" (clause 461) , "bruising" (clause 551), "candid camera" (clause 769) "that would probably take the award" (clause 770). As with the range of microgenres, this indicates that the discourse of Lesson C1 often steers away from the mathematical content.

Table 7.37 Other register items

	Total
REGISTER ITEMS	35
Educational • technical • jargon • non-technical	30 30
Officialese	1
X-ese	
Academic	
Youth Culture	
Other • Gambling • Medical • Film	4 1 1 2

A non-exhaustive taxonomy of the major participants and processes selected in Lesson C1 is given in Table 7.38.

Table 7.38 Taxonomic relations of major participants and processes

Field	Oral linguistic text	Symbolic Text
1. Algebraic expressions (Class)	• those • this • questions For example • minus three [['x' cubed]] 'y' 'z' • minus [outside [[three 'x' minus two]]] • [[four 'x' minus one]] subtract [[three 'x' minus three]] For example • [[thirteen 'a' minus eleven 'b']] • [[[[five 'x' minus two 'y']] minus four 'z']] • // fifteen [[[[four 'a' 'b' plus four [['a' squared]]]] plus two [['b' squared]]]] minus 'a']]	• $3x^2 - 2x - x^2 - 4x$ • $4x^2y \times (-3x^3yz)$ • $5x^2 \times (-3xy) \times (-4x^2) \times (-4y^2) \times (-3)$ • +(3x - 2) • -(3x-2) • (5x - 6) + (3a - 4) • (4x - 5) - (x+6) • (7m +6) - (3m - 5)
2. Simplification of algebraic expression (subclass of class)	• simplify	

3. Components of algebraic expressions (co-meronymy)	• signs • addition sign, plus sign (synonymy) • subtraction sign, minus sign (synonymy) • multiplication sign • division sign • positive signs • negative sign (co-hyponymy) • numbers • letters • brackets • parentheses, braces (co-hyponymy) • like terms • four of these 'x' squareds	• + • - • x For example • 3 • x • ( ) • $3x^2$, x^2
4. Algebraic Properties and Definitions	• the rules • one set of rules [for adding and taking away] • the other separate set of rules [for multiplying and dividing] • [[getting rid [of brackets]]]	• + = same • - = opp sign • +(3x - 2) = 3x - 2 • -(3x-2) = 3x + 2
5. Arithmetic Operations (subclass of class Operative Processes)	• adding, plus (synonymy) • subtract, minus, taking away (synonymy) • multiply, times (synonymy) • dividing • squared	• + • - • x For example • x^2

Several features of the oral discourse become apparent in this display of taxonomic relations. Firstly, major classificatory and compositional items are absent or those that do appear are most commonly non-technical terms. For instance, the term 'algebraic expression' is not used to identify the symbolic statements. The components of the terms of the algebraic expressions are not referred by their technical names of 'constants' and 'variables'. Non-technical items such as "x squareds" and "subtracts" are used to identify particular terms of the algebraic expressions. Reference to the algebraic properties and definitions which are used in the simplification of the algebraic expressions does not occur. Instead the simplification proceeds on the basis of "rules". Addition confusion occurs as distinctions are not made between items such as "addition sign", "plus sign" and "positive sign" on the one hand, and "subtraction sign, "minus sign" and

"negative sign" on the other. Instead, the terms are used interchangeably. This is further discussed in relation to the nuclear configurations.

From the nature of the taxonomic lexical relations, it is apparent that the students in Lesson C1 are engaged in learning the elementary grammar of basic algebraic operations. The content of the Lesson is most typically found in Year Eight and Nine mathematics courses. It is perhaps disturbing to note that shifts to mathematical discourse are not made, as evidenced by the lack of technical taxonomic relations. As previously discussed, this marginal position of the experiential meaning of discourse of Lesson C1 is also evident in the realms of interpersonal and textual meaning.

From the nature of the following exchanges, it becomes apparent that the new content of the lesson is not understood by all students. These exchanges include the following student request.

656 Ben //can you just explain that sign thing again

In addition, the teacher reiterates the content in private-public interactions with the students.

566 T* // if it 's a plus
567 T* // you leave the bracket [[as it is]]
568 T* // if it 's a minus
569 T* // change the sign
570 T* // the first one [on the board] will look like this

The teacher explicitly outlines the new content when the practice examples are demonstrated on the board.

633 T // make sure
634 T // you 've got that line
635 T // that 's the key line
636 T // that 's the new line
637 T // that 's the bit [[we 've just learnt]]
638 T // then it 's [[just collecting terms]]

Student difficulties, however, are explained as a lack of practice.

814 T // look
815 T // it 's a new process
816 T // you have to do quite a few examples
817 T // to get the hang [of it]

At the end of the lesson, the following private interaction between the teacher and a student clearly indicates that the student is still unsure of the new material.

839 S?** // sir
840 T** //<indistinct>
841 S?** // sir
842 T** // what what
843 S?** // how do you know
844 S?** // if it 's a minus or plus sign

After the teacher gives an explanation, the student still seems to be experiencing difficulty.

872 T** // is that OK
873 S?** //mm that <that> will be a plus one though aye

The teacher explains once more.

877 T** // now the rule is [[[[[[if you have a plus sign [outside a bracket]]] you can copy]] what is [in the bracket]]]
878 T** // so if it 's plus
879 T** // it becomes plus
880 T** // if it 's minus
881 T** // it becomes minus
882 T** // in another words it doesn't change
883 S?** // oh yeah yeah yeah
884 T** // yeah
885 S?** // yeah

As I have already suggested in the analysis of the textual meaning of the board text in section 7.243, I believe that differing functions of particular symbolic components, in combination with ambiguities in the oral discourse, contribute to the difficulty that the students are experiencing in grasping the new content of the lesson. In particular, the shifts in functions of the symbols "+" and "-" as process and participant together with the ambiguous experiential meaning of the oral discourse contribute to the confusion which is apparent in Lesson C1.

The shifts in status of the "+" and "-" are acknowledged in the Collins Dictionary of Mathematics. The definition for "plus sign" is "the symbol '+' indicating ADDITION or any analogous operation... or a POSITIVE quantity" (Borowski & Borwein, 1989, p. 452). Similarly, a "minus sign" is "the symbol '-' indicating subtraction or a negative quantity" (Borowski & Borwein, 1989,

p. 380). These distinctions are also found in the definitions for "plus" and "minus". It is clear that in the grammar of mathematics, the symbols "+" and "-" function to realise processes of addition and subtraction in addition to functioning as Classifiers in what is the equivalent of nominal group structures.

As indicated in The Collins Dove Australian School Mathematics Dictionary, one practice aimed at overcoming the problems associated with this duality involves adopting a different notation for the two functions. That is, the forms "+3 and -2 for positive three and negative two" reserve "+ and - in the normal position for addition and subtraction" (Fyfield & Blane, 1992, p. 67). Regardless of this strategy, which may or may not be adopted, the particular status of the symbols in the oral and visual discourse of Lesson C1 merits further investigation.

Parentheses

$+ (3x - 2)$
$= 3x - 2$

$- (3x - 2)$
$= - 3x + 2$

$\therefore$ + = same
- = opp. sign

Figure 7.14 The symbolic board text

To recapitulate on the arguments presented in section 7.243, in the board text given in Figure 7.14 above, the "+" and "-" function as elements in participant structures in the symbolic statements. This is evident from the oral discourse in which "multiplying" by "the invisible one" is repeated on several occasions As previously mentioned, the intended reading is as follows.

$+ (3x - 2) = (+1) \times (3x - 2)$
$- (3x - 2) = (- 1) \times (3x - 2)$

That is, in the board text, the symbol for the one and the symbol for multiplication have been ellipsed in "+ (3x - 2)" and "- (3x - 2)". As a consequence, the "+" and "-" function as Classifiers for the ellipsed Thing,

the "1". As this reading is not explicitly written down, it is not clear that the students follow this interpretation. They have, however just completed practice examples in which the "-" operates as a Classifier as in "$(-3x^3yz)$". Further to this, the function of "+" and "-" as realising the processes of addition and subtraction is questionable as in the board text there is no participant to which the "(3x - 2)" is being added to or subtracted from.

In the oral discourse surrounding the introduction of this new material as given in the excerpt given below, apart from "you are really multiplying everything in there by the invisible one", (clause 527), the teacher refers to "+" and "-" as the "minus sign" and the "plus sign". According to the definitions of these selections, the function of the "+" and "-" is ambiguous.

525 T // if you have just a **plus or a minus sign** [in front of it]
526 T // you really have got an invisible one
527 T // and you are really multiplying everything [in there] [by the invisible one]
528 T // but it is too time consuming and fiddly [[to do that]]
529 T // [with the invisible one] it 's much easier [[to use a short cut rule]]
530 T // and the short cut rule is [[that if you have **a plus sign** [outside a bracket]]]
531 T // your result is [[exactly what 's [in the bracket]]]

Most importantly, in the practice examples given to the students directly after this presentation of the new content, the function of the "+" and "-" shifts from participant to process. That is, in the practice examples

$$(5a - 6) + (3a - 4)$$

and

$$(4x - 5) - (x + 6)$$

the "+" and the "-" function as processes realising addition and subtraction. This is made explicit in the board text by the examples which are expressed as word problems of the board text.

Add (5x +2) to (3x - 1)

Subtract 4x - 1 from 3x -3

In other words, in the oral discourse realising the introduction of the new content of the lesson, the symbols "+" and the "-" were constructed to function as Classifiers in participant structures. This view was reinforced in the hybrid visual text " + = same, - = opp. sign". Other selections in the oral discourse, however, such as "the plus sign" and "the minus sign" realise an

ambiguous position in relation to the function of these symbols. In the practice examples, however, the same symbols function to realise processes. A grammatical shift has occurred in the mathematical symbolism with respect to the functions of "+" and the "-" despite the fact that these examples are intended as practice for the new content of the lesson. However, in the oral discourse, the teacher refers to these symbols as "plus or no sign" (clause 658 for example), and "negative sign" (clause 631 or example) and "the plus's" (clause 664 for example) and "the minus" (clause 665) and "a plus" (clause 665). The functions realised by these selections are either ambiguous, or in the case of "negative signs" realise the function of Classifier in participant structures. Only at the very commencement of the lesson does the teacher specifically identify these symbols as realising a process.

292 T //because things are separated by **an addition or a subtraction sign**

Towards the end of the lesson when the word problems are discussed, the function of the "+" and the "-" as realising processes is alluded to.

719 T //what happens in **the subtract scenario**

I believe that the incongruity of the functions of the "+" and the "-" signs in the theory and practice examples in the symbolic text and the oral discourse contribute to the confusion which at least some of the students are obviously experiencing.

The nuclear configurations of the segment of the oral discourse in which the theory is developed is given below in Table 7.39. As previously mentioned with respect to reference patterns, rankshifted mathematical participants are rarely selected as participants. Instead, the students feature in the Nucleus and Margin as the Medium and Agent. We may note that in this particular excerpt with the exception of two cases of 'multiplying' the processes predominantly involve 'having', 'being', 'copying', 'changing' and 'reversing' as opposed to selections which realise Operative or Mental processes.

Table 7.39 Nuclear Relations

Clause		Centre	Nucleus	Margin	Periphery
		PROCESS = Range: process	+ Medium +Range: entity	+Agent +Beneficiary	x Circum-stance
525 T	// if you have just a plus or a minus sign [in front of it]	• have	• you • a plus or a minus sign		• [in front of it]
526 T	// you really have got an invisible one	• have	• you • an invisible one		
527 T	// and you are really multiplying everything [in there] [by the invisible one]	• multiply-ing	• everything [in there] • [by the invisible one]	• you	
528 T	// but it is too time consuming and fiddly [[to do that]]	• is • too time consuming and fiddly [[to do that]]	• it		
529 T	// [with the invisible one] it 's much easier [[to use a short cut rule]]	• is • much easier [[to use a short cut rule]]	• it • [with the invisible one		
530 T	// and the short cut rule is [[that if you have a plus sign [outside a bracket]]]	• is	• [[that if you have a plus sign [outside a bracket]]]	• the short cut rule	
	## teacher points to + (3x - 2)				
531 T	// your result is [[exactly what 's [in the bracket]]]	• is	• [[exactly what 's [in the bracket]]]	• your result	
	## teacher points to ∴ + = same				
532 T	// in other words you just copy [[what you had [in the bracket]]] down [as your next line]	• copy down	• you • [what you had [in the bracket]]]		• [as your next line]
	## teacher points to = 3x -2				
533 T	// if you have a minus sign [outside the bracket]	• have	• you • a minus sign [outside the bracket]		

534 T	// then you copy the opposite sign [to the things]	• copy	• you • the opposite sign [to the things]		
	## teacher points to the signs in - (3x - 2) = -3x +2				
535 T	// the numbers and the letters don't change	• don't change	• the numbers and the letters		
536 T	// cause when you multiply [by one]	• multiply	• by one	• you	
537 T	// you don't change anything	• don't change	• anything	• you	
538 T	// so [[all you do]] is [[you copy the numbers and letters [[just as they are]]]]	• is	• [you copy the numbers and letters [[just as they are]]]]	• all you do	
539 T	// but the signs reverse	• reverse	• the signs		
540 T	// any questions [on that] then		• any questions		
541 T	// it 's very hard isn't it	• is • very hard	• it		
542 Ss	<indistinct>				

7.252 Field

Although not explicitly stated in Lesson C1, the field of the microgenres concerned with the course content is simplification of algebraic expressions. However, it is apparent by the range of microgenres that the field changes frequently throughout Lesson C1. This further supports my suggestion that learning mathematics is not the major social goal of Lesson C1. As interpersonal meaning is foregrounded, the field of the discussion often steers away from the course content as perhaps an additional strategy designed to maintain the tenor relations. The teacher and students interact and joke with one another about topics other than mathematics. The informal nature of these interactions may allow release of frustration and feelings of inadequacy in connection with the mathematics. One striking aspect of Lesson C1 is that when the field is the mathematical content, technical lexis and other lexicogrammatical constructions such as rankshifted clausal participants are not typically realised in the oral discourse.

7.253 The Mathematical Text

The experiential meaning of the symbolic texts with respect to the shifts in functions of "+" and "-" has been discussed in connection with the oral discourse in the previous section. However, other features of the board text deserve mention.

While the practice questions involving simplification of the algebraic expressions conform to generic specifications, the parts of the board text which involve the explanations of the procedures for simplification represent a radical departure from the genres of mathematics. In particular the following 'statement' is constructed from mathematical symbolism and language.

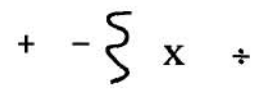
$$\therefore \quad + = \text{same}$$
$$- = \text{opp. sign}$$

Given the non-conventional hybrid form of this statement, the experiential meaning is not clear from the point of view of the lexicogrammar of either mathematical symbolism or language. The intended meaning, however, could be expressed using one of these codes. One such symbolic statement is as follows:

$$a\,(b \pm c) = ab \pm ac$$
$$-a\,(b \pm c) = -ab \mp ac$$

If a symbolic statement such as this had been presented, although the shift from participant to process would nevertheless have still occurred in the practice questions, the ambiguity with respect to the function of "+" and "-" would not have arisen. If may be the case that in the attempt to simplify explanation of the mathematical content, confusion and ambiguity is introduced. Given the difficulties with the practice questions together with the conceptual level of the work completed in Lesson C1, it appears that these students are experiencing limited success in learning mathematics.

A similar strategy is repeated in the following shorthand notation depicting the two 'sets of rules' for addition and subtraction on the one hand, and multiplication and division on the other.



The abbreviated style of presentation is also found in this summary of the order in which the components of algebraic terms are simplified when involved in the process of multiplication and division.

1. - Signs
2. Numbers
3. Letters

The usefulness of such displays is perhaps open to question. It seems to be a feature of Lesson C1 that, unlike Lesson A, board notes do not function to realise details of the reasoning behind the mathematical content. In particular, the notes do not include the properties and definitions on which the simplification of the algebraic expression is based. Further to this, given the non-generic form of presentation, the students would not be able to penetrate a mathematical textbook. The students are not being exposed to the full range of the genres of mathematics.

As one other feature of the experiential meaning of the board text in Lesson C1, we may note that visual cues are also employed to realise experiential meaning as displayed below.

The circle initially focuses attention on the power of three and the arrow directs the viewer's gaze to the three x's which are being multiplied together. The experiential content as the meaning of index notation is further indication that the students are still at the stage of learning the elementary grammar of mathematical symbolism.

To demonstrate the degree of clausal rankshifting which occurs even with simple algebraic expressions such as those found in Lesson C1, the nuclear relations for one problem are displayed in Table 7.40 below. As seen, there is a case of 'Rank 4' in these problems. Notably, there is an absence of contextual information realised thorough a Periphery consisting of

Circumstance. In addition, there is not even a Margin consisting of Agent and Beneficiary. As I have previously commented, the lack of contextual information contributes to the view of mathematics as universal truth.

Table 7.40 Nuclear relations in the symbolic text

	Clause	Centre	Nucleus
		PROC-ESS = Range: proc-ess	+ Medium + Range: entity
1.	**[[[[(4x - 5)]] - [[(x - 6)]]]]**		
	Rank 1		• [[[[(4x - 5)]] - [[(x - 6)]]]]
	Rank 2	• -	• [[(4x - 5)]] • [[(x - 6)]]
	Rank 3 (i)	• -	• 4x • 5
	Rank 3 (ii)	• -	• x • 6
2.	**[[[[[4x - 5]]- x]]- 6]]**		
	Rank 1	• =	• [[[[[[4x - 5]]- x]]- 6]]
	Rank 2	• -	• [[[[4x - 5]]- x]] • 6
	Rank 3	• -	• [[4x - 5]] • x
	Rank 4	• -	• 4x • 5
3.	**[[3x - 11]]**		
	Rank 1	• =	[[3x - 11]]
	Rank 2 (i)	• -	•3x •11

I would like to note that the development of a grammar of mathematical symbolism would allow the individual participant functions and Operative processes to be distinguished in a way that has not been attempted in this study. This important task would lead to a greater understanding of the experiential meaning of mathematical symbolism.

7.26 Logical Meaning

7.261 General Lexicogrammatical Patterns, CONJUNCTION & CONTINUITY and Logical Metaphor

The logico-semantic relations realised in Lesson C1 are displayed in Table 7.41 below. Although the lowest incidence of relations of EXPANSION is found in this lesson, it is similar to that found in Lesson B and Lesson C2. However, if the nature of these relations is examined more closely as displayed in Table 7.44, nearly forty percent of all cases of EXPANSION are implicitly realised in Lesson C1. In addition, the lowest incidence of relations involving PROJECTION occurs in this lesson. From these observations it appears that explicit logical meaning is minimally realised in Lesson C1.

Table 7.41 Logico-semantic relations

NATURE OF RELATION	Total	Percentage (1 d.p.)
	732	100
Expansion	235	32.1
Projection	45	6.1
No relation	452	61.7

As seen in Table 7.42, there are few student contributions that realise logical relations. This trend is also found in Lesson B and Lesson C2.

Table 7.42 Logico-semantic relations: Teacher and student contributions

NATURE OF RELATION	Total	Percentage (1 d.p.)
Expansion (n = 235)		
Teacher	220	93.6%
Students	15	6.4%
Projection (n = 45)		
Teacher	42	93.3%
Students	3	6.7%

Of the selections involving PROJECTION in Lesson C1, only two cases of Locution are realised as seen in Table 7.43. In Lesson A, these types of relations were more frequent as the teacher would revisit and challenge

student answers. This resulted in selections involving Locution, as for example, in the case of "you said". In a similar fashion, relations of PROJECTION involving Idea are minimal. The explicit subjective position realised by, for example, "I think" and the consequent levels of uncertainty are not features of Lesson C1.

Table 7.43 Interdependency and PROJECTION

PROJECTION	n = 45	
	Paratactic	Hypotactic
	0% (0)	100% (45)
Idea	0% (0)	95.6% (43)
Locution	0% (0)	4.4% (2)

The relations involving EXPANSION are displayed in Table 7.44 below. As for each lesson, the majority of relations are paratactic and involve Enhancement. It appears that logical meaning in the pedagogical discourse of mathematics is centred around continuing relations where the meaning in an initial clause is expanded. However, in Lesson C1, the most dominant individual category is hypotactic relations involving Enhancement as realised by selections of "if" and "because". As for each of the other lessons, paratactic relations involving Extension are also common. This is a feature of the field structured nature of the discourse.

The majority of the relations of EXPANSION are external. This indicates that rhetorical strategies for constructing arguments are minimal in Lesson C1. As previously mentioned, many of the Conjunctions and Conjunctive Adjuncts which realise the relations of EXPANSION are implicit. In the case of cohesive and paratactic internal relations, this is certainly true. In addition, as displayed in Table 7.44, the incidence of external paratactic relations which are implicitly realised is also high.

Table 7.44 Interdependency and EXPANSION

EXPANSION	n = 235											
	Cohesive 10.2% (24)				**Paratactic** 52.3% (123)				**Hypotactic** 37.4% (88)			
Elaboration 14.9% (35)	5.1% (12)				7.7% (18)				2.1% (5)			
Extension 32.3% (76)	0.4% (11)				25.5% (60)				2.1% (5)			
Enhancement 52.7% (124)	0.4% (1)				19.1% (45)				33.2% (78)			
External (198) **Internal** (37)	Internal 16		External 8		Internal 19		External 104		Internal 2		External 86	
Explicit (142) **Implicit** (93)	Ex 1	Im 15	Ex 0	Im 8	Ex 3	Im 16	Ex 66	Im 38	Ex 1	Im 1	Ex 71	Im 15
Elucidative (35)												
opposition (24)	1	6				13		1			2	1
clarification (11)		4		1		2		2				2
Additive (47)												
addition (43)		2		1	2		27	9			2	
alternation (4)							4					
Comparative (25)												
similarity (1)				1								
contrast (24)		3		4		1	11	2			2	1
Temporal (34)												
simultaneous (24)										1	22	1
successive (10)							6				4	
Consequential (94)												
purpose (3)												3
condition (32)							3	2			25	2
consequence (49)					1		15	18	1		10	4
concession (6)				1				4			1	
manner (4)											3	1

The trend of Consequential logical relations extends to all lessons. In particular, these involve Consequential relations of 'consequence' and 'condition'. This is not surprising as these types of relations form the basis of mathematical reasoning as realised in mathematical texts. Another trend is the high incidence of Additive relations of 'addition', as would be expected in field structured discourse.

The summary of the relations of EXPANSION realised by the students in Table 7.45 indicates that individually, paratactic relations and Enhancement are most common. However, given the relatively low incidence of these logico-semantic relations, one firm conclusion is that on the whole students are not engaged in constructing logical relations.

Table 7.45 Interdependency and EXPANSION: Student contributions

EXPANSION	n = 15		
	Cohesive	**Paratactic**	**Hypotactic**
	0% (0)	80.0% (12)	20.0% (3)
Elaboration 20.0% (3)	0% (0)	20.0% (3)	0% (0)
Extension 33.3% (5)	0% (0)	33.3% (5)	0% (0)
Enhancement 46.7% (7)	0% (0)	26.7% (4)	20.0% (3)

Next to Lesson B, selections from the system of CONTINUITY in Lesson C1 is the lowest with an average of only 8.0% of clauses containing a Continuative. This radically departs from the logical progression of Lesson A where an average of 19.5% of clauses contained a Continuative. The disjointed nature of Lesson C1 with its multiple shifts in microgeneric states is reflected by this comparatively low incidence of Continuatives.

With these minor exceptions, logical meaning in Lesson C1 is congruently realised. This trend is found across all lessons indicating that grammatical metaphor realising logical relations is not a feature of oral mathematical

pedagogical discourse. In Table 7.46, one exception is the selection of "means" which metaphorically realises the Conjunction "so". This example of grammatical metaphor is common to each lesson in this study.

Table 7.46 Grammatical metaphor and logical relations

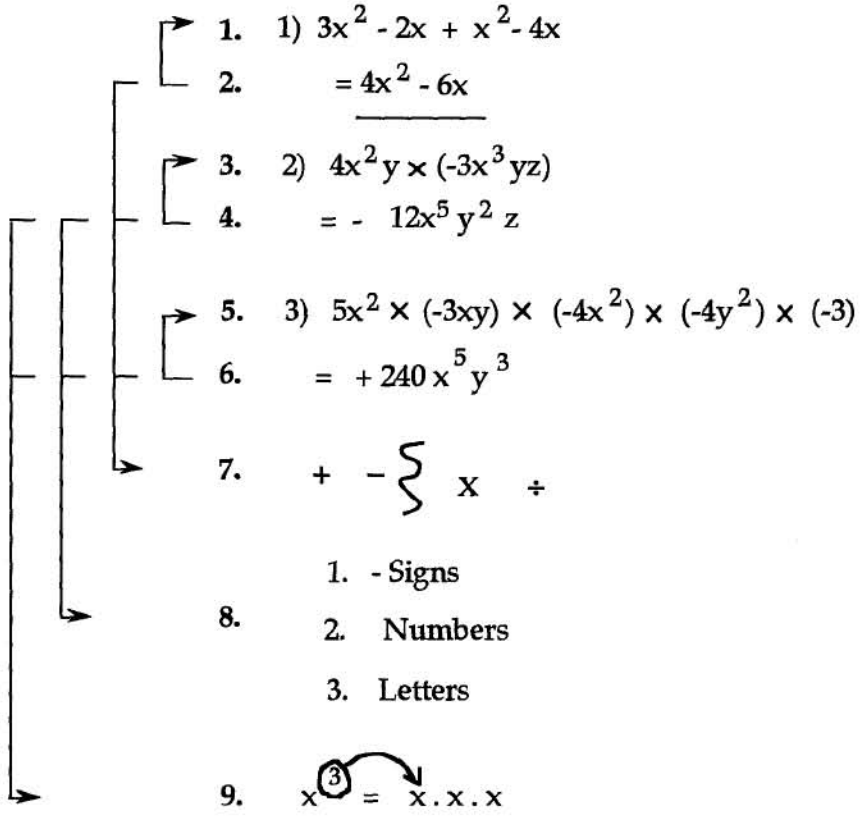
RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause complex: **LOGICAL**	
relator —>	**process**
Examples: then so and	129 T // now that **means** [[that the signs and the numbers [in front of them] tell us]] 246 T // it **means** [[this number tells us]]

7.262 Mathematical Reasoning

Extended implication chains realising mathematical reasoning are not featured in the oral discourse of Lesson C1. Further to this, over forty percent of the logical relations of EXPANSION are implicitly realised. As for each lesson, the majority of relations involve Consequential relations realised by Conjunctions such as "so", "because" and "if" . However, as I have already suggested, the conditions for these Consequential relations are not explicitly realised in the board text. I believe that the abbreviated and hybrid note form of the mathematical definitions and properties in the visual text together with the shifting status of the "+" and "-" signs account for the confusion that arises in Lesson C1 with respect to the reasoning behind the mathematical content.

7.263 The Mathematical Text

The conjunctive reticula for the logical relations for the major part of the board text is given in Figure 7.15 below. As may seen in lines "2", "4", "6", "17" and "18", the mathematical statements are logically connected to the previous statement in the simplification of algebraic expressions. However, it may also be seen that, given the structure of the explanatory notes in the upper section of the board text, the reverse trend is found in that the logical



Parentheses

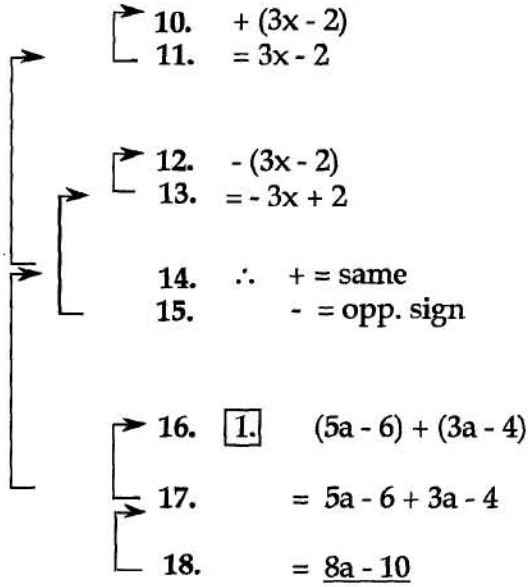


Figure 7.15 Logical relations in the symbolic text

connections point downwards. I believe that if this text was revisited, it might be difficult to reconstruct these logical relations. As previously discussed, this is a function of both the abbreviated style and the conflation of mathematical symbolism and language in non-generic forms.

7.3 The Texture and Ideology of Lesson C1

The method of development of Lesson C1 lacks a coherent global structure such as the one found in Lesson A. Instead the lesson consists of separate activities such as reviewing the previous work, marking the homework, introducing the new content and completing practice questions. Given the number of interpolated microgenres, the method of development is not straightforward. Nevertheless some general observations may be made.

The structure of the majority of the activities represent the 'Stack' whereby macro-Themes and hypo-Themes are followed by amplifying comments. The presence of macro-Themes which highlight the nature of the activity seems to be a feature of pedagogical discourse. In the case below, the Macro-theme appears in the midst of the review part of the lesson.

288 T // today we 're going to look at [[getting rid [of brackets]]]
289 T // where the brackets have more than one thing [in them]

The stages of the lesson are clearly marked as illustrated by the excerpts below.

393 T // OK we now move on [into parentheses]
394 T // or <no> we 've got the homework
395 T // to whiz through

494 T // are you ready [for the next bit]
495 T // or are still some things being sorted out

Within the 'Stack', steplike structures are found, but they are not as sequentially distinct as those found in Lesson B. For instance, in the Student Review Task and Student Review Task Discussion, the 'Step' involves the students attempting the problems, the teacher reviewing the previous work and the marking of the questions. Interspersed amongst these steps, however, are many interruptions. With respect to the new content of the lesson, after the new material is presented, the students are directed to complete three practice questions. These problems, however, differ from the

structure of those introduced with the new content of the lesson as previously explained with respect to the changed status of the "+" and "-" signs. The teacher soon demonstrates the first one on the board. The students continue to work on the remaining two questions. After these are demonstrated, some word problems are introduced. The teacher then directs the students to complete two exercises which contain both types of questions. In combination with the numerous interpolated microgenres, although sequenced, the step-like structures do not always unfold in coherent manner.

The major difference between Lesson A and Lesson B is the lack of structures representing the 'Balance' and the 'Chain'. The structures are predictive as opposed to exploratory and there is a sense of poise and counter-poise. This perhaps relates to the field of the lesson being elementary mathematics. Although the teacher develops the mathematical concepts through different strategies of narrative and analogy, the underlying view is mathematics as a set of rules.

The texture of Lesson C1 differs radically from that of both Lesson A and Lesson B. The weave is loose and the thickness of the fibres is not representative of those typically found in mathematical discourse. The splitting and cojoining of chains and strings is much simpler due to the basic configurations of nuclear relations and patterns of reference resulting from the lack of rankshifted mathematical participants. In addition, the strategy of encoding meaning through grammatical metaphor does not feature in the discourse of Lesson C1.

In contrast to the paths that are cut through the dense levels of meaning in Lesson A, the multiple surges of interpersonal meaning in Lesson C1 result in a series of peaks which are swiftly traversed in a bridge-like fashion. Tenor relations control the discourse of Lesson C1. As the teacher acts quickly to counter the potential threats that constantly emerge in the class relations, this action is undertaken at the expense of the mathematical content. The teacher's strategies of control are covert forms of manipulation which culminate in sarcasm. The humour which consequently erupts as a result of this strategy keeps the class united as an entertained audience at the expense of the individual. This estrangement of a fellow class member acts as deterrent to other students.

This technique of control is countered by the low level of formality in Lesson C1. The colloquial nature of the interactions involve forms of address such as "mate" which are designed to foster solidarity and group cohesion. The field of the discourse strays from the mathematics content as the teacher operates to maintain the tenor relations which are in constant danger of becoming dismantled. Unlike Lesson A and Lesson B, the social goal of teaching and learning mathematics does not ensure stability in the tenor relations.

I have titled this chapter "Learning Mathematics and Acquiescence 1". With respect to the mathematics, apart from the emphasis on the tenor relations and the wide ranging microgenres constituting Lesson C1, other features of the linguistic patterns of the discourse of Lesson C1 cast doubt on the importance of the goal of learning mathematics. Along with the colloquial nature of oral discourse, the mathematical register items are often non-technical terms. The board notes are presented in a non-generic abbreviated format. Further to this, mathematics is conceptualised as a series of rules as opposed to a field of knowledge founded on sets of axioms and definitions. This conceptualisation operates to explicitly realise the dominating position of mathematics and to further marginalise and alienate the students.

In view of the confusion that is evident in Lesson C1, it is apparent that the lexicogrammatical and discourse systems which encode mathematical meaning are not comprehended by the students. Significantly, from the linguistic patterns of Lesson C, it is apparent that the students do not make shifts from constructing everyday reality to mathematical reality. The interpersonal strategies of maintaining control function covertly to undermine any efforts in this direction. Further to this, the interpersonal position of the students does not accord with the tenor relations realised in mathematical discourse. The position of deference is evident from linguistic patterns such as interpersonal metaphor, the covert orientation of the lexical items, the multiple cases of ellipsis, chorus answers, paralinguistic behaviour and colloquialisms.

In conclusion, the final result for these students is marginalisation from the dominant discourses in society. Lacking the necessary resources, the students face either a life of conflict or a life of acquiescence. The strategies of control in Lesson C1 function to make the latter the more probable.

CHAPTER 8

Learning Mathematics and Acquiescence 2

Kevin	Is it 'sin' ?
Students	Sin <indistinct>
Students	Yeah <indistinct>
Teacher	Kevin the 'e' on the end makes the 'in' into 'ine'
Kevin	We didn't do that, that <indistinct>
Teacher	Remember, only dummies call it 'sin'

Extract from Lesson C2

8.1 Contextualisation of School C

The 1995 TEE results for Applicable Mathematics, Calculus and Discrete Mathematics for students at School C are displayed in Figures 7.1, 7.2 and 7.3 respectively in Chapter Seven.

There are two major reasons for including the two lessons given by different teachers at School C. Firstly, the lessons given by a male and female teacher within the same school environment may be compared and, secondly, the discourse arising from a mathematics lesson based on practical activities may be examined.

In Lesson C2 the parameters of a female teacher and a practical lesson give rise to further insights into the nature of mathematical pedagogical discourse. With the step-like structure of the lesson, the monofunctional tendency orientated towards interpersonal meaning found in Lesson C1 does not exist in Lesson C2. Nevertheless, despite variations in the linguistic patterns of each lesson such as differences in social distance and use of covert strategies, selections function to realise a common position of deference. In addition, the practical nature of the lesson and the reliance on visual depiction means that the texture of the discourse of Lesson C2 differs radically from that found in lessons where mathematical reality is semiotically construed through mathematical symbolism. I believe that these observations point towards the limited functionality of practical lessons. While providing intuitive access to mathematical ideas, the transition from everyday discourse to mathematical discourse does not occur with the concrete manipulations and use of visual display as demonstrated by the analysis of the discourse of Lesson C2.

8.2 Lesson C2

The transcript and board texts of Lesson C2 are given in Table 5(i).1 in Appendix 5(i). Lesson C2 is a trigonometry lesson in which the students 'discover' graphically that there are two angles between 0° and 180° which satisfy equations with a positive sine value. An example from this lesson is

$$\sin A = 0.65$$
$$A = 40.5^\circ \text{ or } 139.5^\circ$$

This is achieved by relating the definition of the sine of an angle in a right triangle to the graphical representation of the intersection of an angle and the unit circle in the co-ordinate plane.

The teacher commences the lesson by reviewing the Sine Rule

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

where a, b and c are the lengths of the sides of the triangle and A, B and C are the opposite angles. The students are reminded of the homework question which involves constructing the obtuse angled triangle which results from use of this rule. The teacher reviews this problem in the final stages of lesson from the perspective of the new content.

The students are given graph paper which consists of the unit circle and angles marked at 10° intervals. After marking in the scale for the x and y axes and constructing a table with columns 'angle', 'x', 'y', 'sin' and 'cos', the students draw angles on the graph paper between 0° and 90° and fill in the appropriate columns in the table. In this way, the idea that the x co-ordinate is the cosine value and the y coordinate is the sine value is developed. This relationship is explained by drawing a right triangle with hypotenuse of length one and sides 'x' and 'y' and using the right triangle definitions for sine and cosine. The students repeat the procedure for angles between 90° and 180° where it is seen that another angle gives the same sine value and that the cosine values are negative in this quadrant. It is established that the two angles which given the same sine values are supplementary. Following this, the teacher works through the homework exercise which involves using the Sine Rule to find the size of an angle in a diagram of a triangle.

Using the results of the practical activity, the teacher finds the two solutions for the angle. Following a student request, the teacher demonstrates the construction of the two triangles which result from this solution. The students are then instructed to complete a similar example.

8.21 The Curriculum Macrogenre and the Lesson Genre

As displayed in Table 8.1, Lesson C2 is a Practical Lesson which realises the Curriculum Development stage in the curriculum macrogenre. In Lesson C2, the students are engaged in the practical activity of drawing the angles and recording the results as the major strategy for developing the new content of the lesson.

Table 8.1 The stages of the curriculum macrogenre and the constituent lesson genres

STAGES	LESSON GENRE
Curriculum Initiation	Review Lesson
Curriculum Development	Theory Lesson Theory/Practice Lesson Practice Lesson **Practical Lesson**
Curriculum Application	Theory Applications Lesson Theory/Practice Applications Lesson Practice Applications Lesson Practical Applications Lesson
Curriculum Review	Topic Review Lesson
Curriculum Evaluation	Test/Examination Test/Examination Followup

The objectives of the lesson are found in the Measurement strands of both Mathematical Development Unit 5.3 and Mathematical Development Unit 6.3. The appropriate objectives are:

Objective M5.2 Determine the sine and cosine of an angle, using a variety of methods
(Curriculum Directorate, 1988, p. 7)

Objective M6.1 Determine and use the sine and cosine rules
(Curriculum Directorate, 1990b, p. 25)

While it may appear that each of the objectives of Unit 5.3 were not completed at the time the unit was taught to the students of Lesson C2, the discrepancy is largely due the organisation of the mathematics content in the Unit Curriculum. In Mathematical Development Unit 5.3, emphasis centres around the right angle triangle definition of the trigonometric ratios to the exclusion of the circular function interpretation. This makes comparisons with the conceptual level of Lessons A and Lesson C2 somewhat difficult. I believe, however, that students in Lesson A would have covered the content of Lesson C2 as the means for introducing the trigonometric ratios.

8.22 The Microgenres

The sequence of microgenres constituting Lesson C2 is displayed in Figure 8.1 and listed by number of first appearance below.

2. **Settling into Work (SIW)**
PRE-LESSON GENRE:
1. **Teacher Preparation (TP)**
PRE-LESSON GENRE
3. **Student Conversation(SC)**
PRE-LESSON GENRE
4. **Teacher Conversation (TC)**
PRE-LESSON GENRE
13. **Teacher-Student Private-Public Interaction (TSPPI)**
INTERPOLATED GENRE
15. **Student-Student Private Interaction (SSPI)**
INTERPOLATED GENRE
20. **Review (R)**
PRELIMINARY GENRE
9. **Student Interruption (SI)**
INTERPOLATED DISRUPTIVE GENRE
30. **Homework Discussion (HD)**
PRELIMINARY GENRE
39. **Practical Activity (PA)**
MAIN LESSON GENRE
15. **Student-Student Private Interaction (SSPI)**
INTERPOLATED GENRE
40. **Practical Activity Discussion (PAD)**
MAIN LESSON GENRE
14. **Teacher-Student Private Interaction (TSPI)**
INTERPOLATED GENRE
8. **Teacher Disciplinary Interruption (TDI)**
INTERPOLATED DISRUPTIVE GENRE

23. **Diagnostic Activity (DA)**
MAIN LESSON GENRE
35. **Seatwork (SW)**
MAIN LESSON GENRE

After the initial Review and Homework Discussion, the structure of the lesson is best described as a constant shuttle between the microgenres Practical Activity, Practical Activity Discussion and Teacher-Student Private-Public Interaction. That is, the lesson progresses as a series of movements between specific microgenres. The teacher issues directives to the students and while these tasks are being completed the teacher monitors progress by moving around the classroom and interacting with the students. After this task is discussed, the next advance is made. Rather than being given a complete task with a set of directions, the students are carefully directed and monitored at each stage. As may be seen from the graphical display, this is interspersed with constant talking as realised by Student-Student Private Interaction microgenre. In the final stages of the lesson, the pattern changes when the homework is discussed in the Homework Discussion microgenre.

Although there are Student Interruptions during the initial and final stages of the lesson, there is only one Teacher Disciplinary Interruption. It appears that the momentum of the lesson derived from the step-like instructions ensures that the field does not divert to other areas.

The transition matrix given in Figure 8.2 captures the shuttle-like movements in the structure of Lesson C2. As may be seen, there are multiple transitions between the Practical Activity, the Practical Activity Discussion and Teacher-Student Private-Public Interaction microgenres. As we may also note, there are five instances of transitions into the Student Interruption microgenre with only one arising in connection with the practical activity.

From these observations it is evident that the strategy of small advances in a hands-on activity operates to minimise student interruptions and to maintain the field of the lesson as the mathematical content. The one transition to the Teacher Disciplinary Interruption is a further indication of the success of this strategy. However, perhaps it is rather like working on an assembly line where a series of small tasks ensure maximal efficiency in the manufacturing process but one in which the workers lack understanding of the global process instigated by others. In an analogous manner, it is the

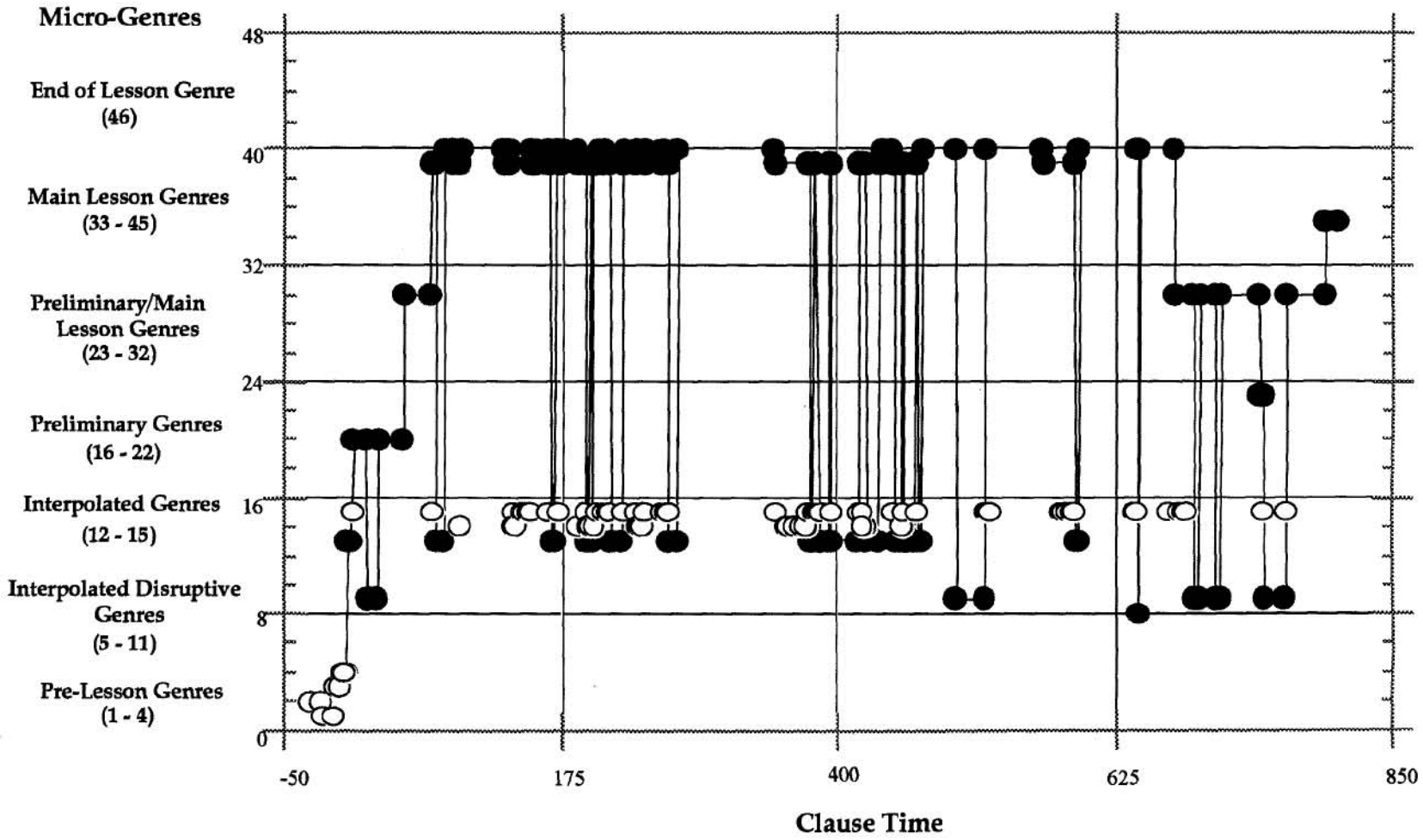


Figure 8.1 Lesson C2 - The sequence of microgenres

To

From		TC	TDI	SI	TSPPI	R	DA	HD	SW	PA	PAD
	TC				1						
	TDI										1
	SI					1		3			1
	TSPPI					1				9	5
	R			1				1			
From	DA			1							
	HD			2			1		1	1	
	SW										
	PA				14						9
	PAD		1	1				1		13	
	Total		1	5	15	2	1	5	1	23	16

Figure 8.2 Lesson C2 - The microgenre transition matrix

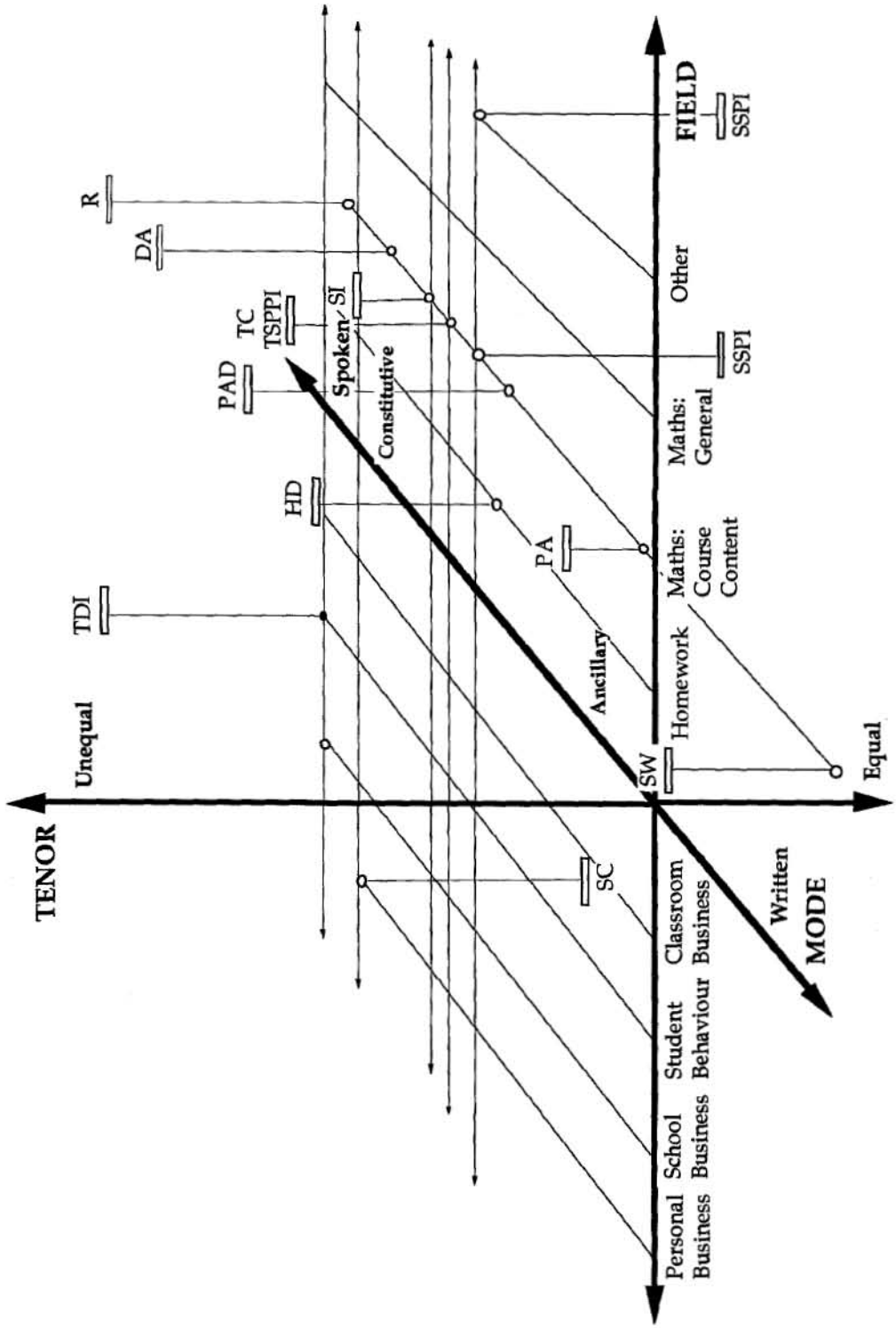


Figure 8.3 Lesson C2 - Dimensions of the microgenres

teacher who summarises the new concepts which have been developed in Lesson C2. Unfortunately there is insufficient feedback from the students to determine the level of comprehension of the new content. This points to the need for extended studies of different classes.

The narrow range of the microgenres of Lesson C2 are displayed in Figure 8.3. As may be seen, the field rarely deviates from the course content, the tenor relations are unequal and there is a range of mode selections. With its narrow range of field selections, Lesson C2 appears to share certain characteristics with Lesson A. However, as I demonstrate in this chapter, the lessons are fundamentally dissimilar in a way that stretches beyond the different lesson genres and microgeneric selections.

8.23 Interpersonal Meaning

8.231 General Lexicogrammatical Patterns, NEGOTIATION and Interpersonal Metaphor

A summary of the major features of the exchange structure is given in Table 8.2 below. The length of the exchanges is comparable with Lesson A as the longest found in the four lessons which have been analysed. In addition, Lessons A and C2 share approximately the same ratio of teacher clauses to student clauses. However, I would like to note that thirty of the 129 student clauses or 23.3% are public-private interactions which occur when the teacher moves around the room. This may be compared to Lesson A where all student contributions occur as public interactions. Although the ratio of the teacher to student clauses is similar, the context of the situation in which the student contributions are made is different as revealed by the projection. Further to this, as I demonstrate in the course of this chapter, these differences extend to each dimension of the student contributions.

Table 8.2 Exchange structure

NATURE OF EXCHANGES	
Number of Exchanges	194
Average Length of Exchange	3.43 clauses
Teacher Initiated Exchanges	187
Student Initiated Exchanges	7
Ratio of teacher clauses: student clauses	1: 0.24

The number of student initiated exchanges in Lesson C2 is minimal as in the other lessons, with the largest number occurring in Lesson C1. The first clauses in the student initiated exchanges in Lesson C2 are reproduced below in Table 8.3. These exchanges are sprinkled throughout the lesson and mainly function for clarificatory purposes. That is, with the exception of exchanges 73 and 162, the MOOD selections are interrogative with exchange 706 metaphorically realising a command through the modalised polar interrogative. It appears that in Lesson C2, students interrupt the current microgenre or more commonly participate in public-private exchanges with teacher to ascertain what is required, to clarify the content and to inform the teacher of difficulties. With the exception of the rebuff resulting from the student request to "slow down" (clause 706), the teacher acts on the student initiative. That is, in Lesson C1 the teacher resorts to covert strategies to stem student initiatives which at times are perceived as threats of potential unrest in the classroom. In Lesson C2 the student requests are taken as genuine enquiries to which the teacher responds. This reveals a directness in the tenor relations which is lacking in Lesson C1.

It is interesting to note that the variety of interactions stemming from student initiatives do not occur in Lesson A. In this lesson, the only interruption by student serves to challenge the teacher with respect to the method for solving the trigonometric problem. That is, the tenor relations in Lesson A realise a formal situation whereby student initiatives function only within a restricted range.

Table 8.3 First clause in student initiated exchanges

Clause N°/ Speaker	Exchange N°	Clause
17 Kev	6	// is it 'sin'
165 S? *	45	// what do we have to do
295 S1 *	73	// that 's one unit
387 S2 *	94	// miss how come [[the sine doesn't come up negative]]
466 S? *	108	// miss do you have to draw the one fifty and the one seventy
688 S?	162	// I can't find it
706 Mel	169	// can you slow down [a bit] miss

The speech roles for the teacher and students are given below in Table 8.4. With the exception of Lesson B where the student input is minimal, the patterns are similar across all lessons. The teacher's position of power is evident from the speech role of primary knower and secondary actor with

the latter role slightly more pronounced in Lesson C2. This reflects the practical nature of the lesson. Significantly, patterns of deference are realised in Lessons C1 and C2 with approximately the same incidence of chorus responses indicated by the speech role 'K3' and 'Kn' in Table 8.4. From this observation it is evident that the students operate as a collective rather than as individuals who are personally responsible for their contributions.

Table 8.4 Speech roles of the teacher and students

Ranking Clauses: SPEECH ROLES (n = 665)	Teacher		Student	
	Total	Percentage (1 d.p.)	Total	Percentage (1 d.p.)
Knowledge	405	60.9	119	17.9
Primary Knower (dK1, K1, K1f)	402	60.5	2	0.3
Secondary Knower (K2, K2f)	3	0.5	72	10.8
Secondary Knower (K3, Kn)			45	6.8
Action (n = 123)	131	19.7	10	1.5
Primary Actor (dA1, A1, A1f)	12	1.8	3	0.5
Secondary Actor (A2, A2f)	119	17.9	6	0.9
Secondary Actor (An)			1	0.2

Table 8.5 Selections of SPEECH FUNCTION

Ranking Clauses: SPEECH FUNCTION	The Lesson		Teacher Contribution		Student Contribution	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
	665	**100**	**536**	**80.6**	**129**	**19.4**
Knowledge	**524**	**78.8**	**405**	**60.9**	**119**	**17.9**
Calls	6	0.9	6	0.9	0	0.0
Propositions	336	50.5	269	40.5	67	10.1
Dynamic Moves	161	24.2	114	17.1	47	7.1
Follow-up	9	1.4	8	1.2	1	0.2
Reacting	12	1.8	8	1.2	4	0.6
Action	**141**	**21.2**	**131**	**19.7**	**10**	**1.5**
Proposals	109	16.4	107	16.1	2	0.3
Dynamic Moves	27	4.1	21	3.2	6	0.9
Follow-up	3	0.5	3	0.5	0	0.0
Reacting	2	0.3	0	0.0	2	0.3

The selections in Lesson C2 from the system of SPEECH FUNCTION are summarised in Table 8.5. As for each lesson, the majority of moves are

associated with knowledge. In Lesson C2, however, the percentage of Dynamic Moves associated with knowledge matches Lesson A. This phenomenon was reflected in the length of the exchanges. As will be seen, however, the majority of these Dynamic Moves are realised by teacher.

The selections of SPEECH FUNCTION and MOOD are listed in Table 8.6. These are also displayed in connection with the speech role of the teacher and students in Tables 5(ii).1 to 5(ii).8 in Appendix 5(ii).

Table 8.6 SPEECH FUNCTION and MOOD: Teacher and student contributions

	KNOWLEDGE						ACTION				
TOTAL	Call	Prop-ositn	Dyn-Move	Foll-Up	Rea-cting	Total	Prop-osal	Dyn-Move	Foll-Up	Rea-cting	Total
Decl-arative 457 68.7%		274	113	5	6	398 59.8%	38	19	3		59 8.9%
Teacher		215	77	4	4		37	16	3		
Student		60	196	1	2		1	3			
YN-interrog 27 4.1%		13	9			22 3.3%	5				5 0.8%
Teacher		10	9				4				
Student		3					1				
WH-interrog 62 9.3%	2	38	22			62 9.3%					0 0.0%
Teacher	2	37	15								
Student		1	7								
Imper-ative 95 14.3%	1	8	10	1		20 3.0%	65	6			71 10.7%

Teacher	1	5	9	1			65	6			
Student		3	1								
Exclam-ative 3			1		2	3					0
0.5%						0.5%					0.0%
Teacher			1		1						
Student					1						
Paralingu istic 12		1	2		4	7	1	2		2	5
1.8%						1.1%					0.8%
Teacher					3		1				
Student		1	2		1			2		2	
Minor Clause 12	3	2	4	3		12					0
1.8%						1.8%					0.0%
Teacher	3	2	3	3							
Student	0	0	1								
665	6	336	161	9	12	524	109	27	3	2	141
100%						78.8%					21.2%

The patterns of deference realised through selections of MOOD and SPEECH FUNCTION in Lesson C2 replicate to different degrees the dimensions of those found in Lesson B and Lesson C1. For example, although paralinguistic behaviour occurs proportionally more often in the discourse of Lesson C1 and C2, the greatest incidence in found in Lesson C1. On the other hand, tagging of declaratives occurs proportionally more often in Lesson B and C2 with the highest incidence is found in Lesson B. The patterns of deference in Lesson C2 are best analysed through closer examination of these tagged declaratives, teacher commands and the nature of student responses.

The declaratives selecting for Mood Tags in Lesson C2 are listed in Table 8.7 below. There is a relatively high incidence of tagging which occurs in connection with statements concerned with the mathematical content in

addition to the politeness tag "please". We may note that the tagging of declaratives may be a pattern of deference which is gender specific as revealed by the patterns found in Lesson B and Lesson C2.

Table 8.7 Mood Tags

Clause N°/ Speaker	MOOD TAG
10 T	// quickly jot down the sine rule [on your page] **please**
49 T	// that the angle had to be an obtuse angle [in the triangle] **didn't I**
87 T	// OK also could you **please** take another sheet of paper
128 T	// mark those [on your axes] now **please**
140 T	// yes **please**
159 T	// it doesn't meet [right on one] **does it**
163 T	// so it 's going to be point nine something **won't it**
241 T	// you like this **do you**
254 T	// OK that 's pretty obvious <<**isn't it**>> [from the table]
300 T	// cause it 's the radius [of the circle] **isn't it**
305 T	// it 's the same [as the little bit [of the 'y']] **isn't it**
428 T*	// and one 's come up positive **hasn't it**
431 T *	// cause you 're still reading 'y' **aren't you**
434 T *	// you 've actually gone [to the other side [of the zero]] **haven't you**
481 T	// they still matched **didn't they**
543 T	// no there 's another way [[of saying that]] **isn't there**
563 T	// the pairs are [[such that they 're supplementary]] **aren't they**
612 T	// so we got close [to forty] **didn't we**
628 T	// the sine [of some angle] is zero point six five **couldn't I**
691 T	// and just watch here **please**

The MOOD selections for the commands realised by the teacher are displayed in Table 5(ii).6 in Appendix 5(ii). The practical nature of Lesson C2 means that there are proportionally a greater number of moves realising commands than any other lesson. Significantly, while not as extreme as Lesson A, patterns of interpersonal congruence are found as the high ratio of commands which are realised through imperative MOOD. This feature of the discourse merits closer examination.

There are two possible explanations for the interpersonal congruence realised in the teacher commands of Lesson C2. Firstly, the practical nature of Lesson C2 means that the teacher is repeatedly issuing commands within a step-like structure. As for instructions found in any manual or cookbook, interpersonal metaphor is not appropriate in this context. Secondly, commands in Lesson B and C1 realise interpersonal metaphor while those in Lesson A and Lesson C2 realise interpersonal congruence. That is, the

male teacher interacting with female students engages in interpersonal metaphor in Lesson B, as does the male teacher interacting with working class students in Lesson C1. However, the female teacher interacting with working class students engages in interpersonal congruence in Lesson C2 as does the male teacher interacting with male students in Lesson A. There appears to be an equality of status between the latter two groups as reflected in the MOOD selections for commands. Significantly, a difference lies in the relativity of that status. In Lesson A, the power dominating relations reflected in each dimension of interpersonal meaning realise the maximal social status of the interlocutors. However, although power dominating relations are evident through interpersonal congruence of the commands in Lesson C2, as I demonstrate, other selections realising interpersonal meaning function to realise low status. That is, the teacher and student interact in patterns of equality which reflect a deferential position. Being posited on the bottom of the social scale means that interpersonal metaphor which masks unequal power relations is not perhaps as necessary as when hierarchical social differences exist as in Lesson B and Lesson C1.

The imperative commands which select for Mood are listed in Table 8.8. With the two exceptions of the Finites realising negative polarity, the selections consist of second order imperatives realised through "let's". This establishes group cohesion as realised in Lesson A and B.

Table 8.8 Imperative commands with MOOD structure

Clause N°/ Speaker	Subject	Finite	Residue
59 T		don't	tell me
177 T	let's		jump
349 T	let's		move on then
351 T	let's		go [past an acute angle]
352 T	let's		go [further around the circle] [to the angle one hundred]
469 T	let's		go through [[what you 've just discovered]]
484 T	let's		be a bit more specific then
595 T	let's		let's see
615 T		don't	forget

The nature of the extended interactions of Lesson C2 warrants closer inspection. One such interaction is given in Table 8.9.

Table 8.9 Moves, stages of exchange structure, SPEECH FUNCTION, MOOD selections

Clause N°/ Speaker	Ex-change N°	Clause	MOVE, SPEECH ROLE, STRUCTURE, SPEECH FUNCTION, MOOD
270 T	70	// OK the important thing now why	Proposition, K1, K-Initiation, statement, declarative
271 T	71	// why do you think	Proposition, dK1, K-Continuation, question, WH-interrogative
272 T	71	// that is happening	Proposition, dK1, K-x, question, declarative
273 T	71	// let's look at our unit circle	Dynamic, K1, K-Initiation, check, imperative
274 T	71	// let's look at the one [with ten degrees]	Dynamic, K1, K-Continuation, check, imperative
275 T	71	// why is it happening	Dynamic, K1, K-Initiation, replay, WH-interrogative
276 Ss	71	// <silence>	Proposition, K2, K-Response, answer, disclaimer
277 T	71	// suggestions	Dynamic, K1, K-Initiation, backchannel, YN-interrogative
278 T	71	// a hint	Dynamic, K1, K-Initiation, clarification, none
279 T	71	// a little hint	Dynamic, K1, K-Initiation, replay, none
280 T	71	// what sort [of line] did we say	Dynamic, K1, K-Request, check, WH-interrogative
281 T	71	// that one was there	Dynamic, K1, K-x, check, declarative
282 Ss	71	// perpendicular	Dynamic, Kn, K-Response, check, declarative
283 T	71	// a perpendicular line	Dynamic, K1, K-Initiation, replay, declarative
284 S?*	71	// two right angles	Dynamic, K2, K-Response, check, declarative
285 T	71	// what have we done	Dynamic, K1, K-Request, clarification, WH-interrogative
286 T	71	// tell me again	Dynamic, K1, K-Request, replay, imperative
287 Ss	71	// two right angles	Dynamic, Kn, K-Response, replay, declarative
288 Ss	71	// right angled triangle	Dynamic, Kn, K-Response, replay, declarative
289 T	71	// we 've made a right angled triangle	Dynamic, K1, K-Initiation, clarification, declarative
290 T	71	// here it is here	Dynamic, K1, K-Continuation, clarification, declarative

Although the average length of the exchanges may be similar to that of Lesson A, the nature of the exchanges is radically different as illustrated by the above example. The teacher coaxes a response from the students after the initial disclaimer (clause 276) through a series of Dynamic Moves. That

is, the teacher abandons the conceptual difficulty of the first question and rephrases the interrogative as a series of simple questions in a manner which is analogous to the step-like structure of the lesson. As such, the students respond to conceptually simple interrogatives with what are most often ellipsed answers. These patterns are a feature of the discourse of Lesson C2 which explain the length of the exchanges. The nature of the student responses is examined in more detail below.

As displayed in Table 5(ii).4 in Appendix 5(ii), student contributions as secondary knower consist of responses to questions realised as declaratives with only two disclaimers. Strikingly, the student responses are short, as there are only four instances of K-Continuation moves and no K-x moves. The students, however, initiate Dynamic moves on ten occasions and make Requests on eight occasions. This represents the highest incidence of such moves. As previously mentioned, however, many of these occur when the teacher is interacting with the students at their desks. As for each lesson, the students are more likely to respond to Dynamic Moves initiated by the teacher.

Patterns of deference are realised in Lesson C2 through paralinguistic selections, chorus responses and the minimally extended contributions of the students. Patterns of ellipsis in the clausal analysis as displayed in Table 8.10 provide further evidence of this positioning.

Table 8.10 Clausal analysis

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	662	100
MAJOR CLAUSES	636	96.1
Complete	481	72.7
Ellipsed	146	22.1
Abandoned	8	1.2
MINOR CLAUSES	26	3.9
NON-CLASSIFIED/UNKNOWN CLAUSES	42	

As for Lesson C1, over one fifth of all clauses are ellipsed. If the student contribution is considered as displayed in Table 8.11 below, nearly sixty

percent of student clauses are ellipsed. Although comparable with Lesson B and Lesson C1, this is the highest incidence of student ellipsis found in the four lessons. The summary of the patterns of the private interactions listed in Table 8.12 reflect this pattern.

Table 8.11 Clausal analysis: Teacher and student contributions

	Teacher		Student	
	Total	% (1 d.p.)	Total	% (1 d.p.)
CLASSIFIED CLAUSES (Total 662)	535	80.8	127	19.2
RELATIVE PERCENTAGES	535	100	127	100
MAJOR CLAUSES	519	97.0	117	92.1
Complete	442	82.6	39	30.7
Ellipsed	71	13.3	75	59.1
Abandoned	6	1.1	2	1.6
MINOR CLAUSES	16	3.0	10	7.9
NON-CLASSIFIED/UNKNOWN CLAUSES	5		37	

Table 8.12 Clausal analysis: Private interactions

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	55	100
MAJOR CLAUSES	46	83.6
Complete	21	38.2
Ellipsed	25	45.5
Abandoned	0	0.0
MINOR CLAUSES	9	16.4
NON-CLASSIFIED/UNKNOWN CLAUSES	46	

The types of modality and modulation realised in Lesson C2 are displayed in Table 8.13 below. Modality is exclusively concerned with probability and modulation with primarily obligation. Although there is slightly higher incidence of modulation found in Lesson C2, these patterns are similar across all lessons

Table 8.13 Modality and modulation

(n = 533)	Totals	Percentage
MODALITY	435	81.6
Probability	435	
Usuality	0	
MODULATION	98	18.4
Obligation	93	
Inclination	3	
Potentiality	2	

The value and orientation of modality associated with probability is displayed in Table 8.14. The modality is predominantly maximal with 73.1% of cases realising absolute certainty through modal congruence. Generally speaking, however, while the modality is high, Lesson C2 with Lesson B realise lower levels of certainty, as displayed by the incidence of median and low values. These patterns suggest that the trend of a relatively lower modality is gender specific. On the other hand, the lower explicit selections of metaphorical realisations found in Lessons C1 and C2 suggests that plays on certainty are a facet of an elaborated code.

Table 8.14 Probability: Modality

ORIENTATION/ VALUE	Objective		Subjective	
(n = 435)	Implicit	Explicit	Implicit	Explicit
Maximal	318 (73.1%)	4 (0.9%)	1 (0.2%)	15 (3.4%)
High	11 (2.5%)			
Medium	7 (1.6%)		38 (8.7%)	1 (0.2%)
Low	9 (2.1%)		30 (6.9%)	1 (0.2%)

The values and orientation for obligation are displayed in Table 8.15 below where it may be seen that, apart from four cases, the value is maximal.

Commands are to be obeyed without question. This pattern extends to the values of inclination displayed Table 8.16.

Interestingly there is an emphasis on commands to the exclusion of offers in Lessons C1 and C2 when compared with Lessons A and B. In the latter two lessons, the extent to which the teacher offers service to the students outstrips that found in the lessons of working class students. This is perhaps indicative of differing social goals of the lesson where one is orientated towards learning mathematics and the other towards learning submission.

Table 8.15 Obligation: Modulation

ORIENTATION/ VALUE (n = 93)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal			89 (95.7%)	
High				
Medium	2 (2.2%)		1 (1.1%)	
Low			1 (1.1%)	

Table 8.16 Inclination: Modulation

ORIENTATION/ VALUE (n = 3)	Objective		Subjective	
	Implicit	Explicit	Implicit	Explicit
Maximal	1 (33.3%)		2 (66.6%)	
High				
Medium				
Low				

There are no Comment Adjuncts in the discourse of Lesson C2 and as displayed in Table 8.17 below, there are only forty selections of Mood Adjuncts. This is the lowest incidence of Mood Adjuncts found in the lessons. Nearly half of these function to lower intensity as realised by "just"

while the majority of the remainder are concerned with time. Further to this, only eight Mood Adjuncts are thematic indicating the minor function of these adjuncts as flavouring the point of departure for the message. The patterns across the lessons indicates that selections of Mood Adjuncts may be a feature of an elaborated code.

Table 8.17 Mood Adjuncts

	Total	Percentage (1 d.p.)
MOOD ADJUNCT	40	100
Intensity	19	47.5
Degree	5	12.5
Time	9	22.5
Presumption	3	7.5
Probability	4	10.0
Usuality		
Ranking Clauses	33	82.5
Rank-shifted Clauses	7	17.5
Mood Adjuncts per ranked clause (n = 665)	$\frac{40}{665} = 0.06$	
Thematic Mood Adjuncts	8	20.0
Student contribution	2	5.0

Although the vast majority of Polarity selections are positive, the highest incidence of negative polarity is found in Lessons C1 and C2. However, as seen in Table 8.18, these account for only four percent of ranking clauses.

Table 8.18 Polarity

POLARITY	Total	Percentage (1. d.p.)
Total	530	100
Positive	509	96.0
Negative	21	4.0

The orientation of lexical items of address, fixed expressions, colloquialisms, slang terms, anaphoric nouns and attributes, attitudinal lexis, amplification and others is summarised in Table 8.19. The majority of items function to

realise neutrality, with only four items functioning as overtly positive and ten as covert.

Table 8.19 Orientation of lexical items

	Total	Percentage (1. d.p.)
LEXICAL ITEMS	104	100
NEUTRAL	87	83.7
OVERT	4	3.8
Positive	4	
clined	4	
laudatory		
Negative		
clined		
condescending		
critical		
COVERT	10	9.6
Euphemism	9	
straight-euphemism	9	
dysphemic -euphemism		
Dysphemism	1	
straight-dysphemism	1	
euphemistic -dysphemism		

The items which function covertly in Lesson C2 are listed below in Table 8.20. With the exception of "dummies" (clause 23), the selections function as euphemisms which replace other lexical choices which are neutral or have less favourable connotations.

The dysphemic expression 'dummy' is defined by Partridge as "A person notably deficient in ability or brightness..." (1972, p. 287). Perhaps this one example encapsulates the heart of the matter. By giving the phonetic version "sin" as the abbreviation for 'sine', the student is labelled as deficient in intelligence. Presumably 'intelligent' students would have known to say "sine A" despite the fact that it is written as 'sin A'. In this example it is glaringly obvious this measure of intelligence is no more than knowledge of the conventions and generic forms of mathematics. In opposition to the logic on which our educational system is founded, intelligence is not a measure of a student's innate capabilities. It is a

measure of the subject's access to and participation in the genres which constitute dominant discourses. As I argue in this study, this access is a function of the subject's positioning according to gender and social class as reflected in the differing textures of classroom discourse.

Other lexical selections function to accentuate or spike interpersonal meaning as in the case of "amazing" (clauses 228 and 229) and "whoops" (clause 705). As with paralinguistic behaviour such as "oooh" (clauses 220 and 224), the teacher injects the discourse with colour to attract and maintain the interest of the students. Although colourful lexical selections such as "exciting" function in the other lessons to realise the opposite meaning in much the same way as "amazing", these paralinguistic selections do not occur in the other lessons. Paralinguistic displays of feelings which realise enthusiasm, support and surprise are restricted to the female teacher in Lesson C2. Through use of these strategies, the social distance between the teacher and the students is reduced. The low social distance is also manifested physically as the teacher moves around the room interacting with the students.

Table 8.20 Covert Expressions

Clause N°/ Speaker	Clause
8 T	//**thank you**
23 T	// **only dummies** call it 'sin'
228 T	// **some amazing things** happening
229 T	// if you have discovered [[**something amazing** happening]]
387 S2 *	// **miss** how come [[the sine doesn't come up negative]]
466 S? *	// **miss** do you have to draw the one fifty and the one seventy
684 T	//**thank you**
705 T	// **whoops** [upside down]
706 Mel	// can you slow down [a bit] **miss**
743 T	//**great**

The strategy of increasing the volume of interpersonal meaning through amplification of items by repetition and intensification is used in Lesson C2. These include cases of intensification, "all that stuff" (clause 2), "you've all" (clause 62), and "as the little bit of the y" (clause 305). These strategies combine in "a hint, a little hint" (clauses 278 and 279). We may note that rather than making selections of intensification which enlarge, the choice of "little" operates to diminish.

Table 8.21 Amplification of general lexical items and register specific items

	Total
AMPLIFIED LEXICAL ITEMS	3
Intensification	3
straight intensification	3
hyperbole	
understatement	
Iteration	1
VARIETY	
Standard	3
Colloquial	1
REGISTER - mathematics	0

In addition to "dummies" (clause 23), "amazing" (clause 228) and "great" (clause 743) listed in Table 8.20 as covert items, other selections such as "a good thing" (clause 461) and "good" (clause 111) function overtly to realise attitude. The proliferation of lexical items realising attitude does not match the range found in Lessons B and C1 but on the other hand, clearly outstrips that found in Lesson A where feelings are kept firmly backstage.

Table 8.22 Attitudinal lexis

	Total	Percentage
Items	8	100
Variety	4	50
Standard	4	50
Colloquial		

Compared with the other lessons, choices of Vocatives are minimal in Lesson C2 as seen in Table 8.23 below. Three of the four cases of non-name are realised through the student selection "miss" (clause 387, 466 and 706). Other selections involve the students' first name with one hypocorism "Sam" (clause 496). Rather than publicly addressing students, the teacher moves around the room to interact with students on a more private basis. The close proximity means that address is an option which is not usually chosen. In the public arena as realised in the Practical Activity Discussion, Review and Homework Discussion, unlike Lesson A in particular, personal responsibility for individual contributions is minimal. As previously discussed, students often answer in chorus or call out without being

nominated. The general orientation of Lessons C1 and C2 is towards the group rather than the individual. The ideological implications of these differing orientations of Lesson A compared with Lessons C1 and C2 revolve around positions of power versus positions of deference. These ideas are fully explored in Chapter 9.

Table 8.23 Forms of address

ADDRESS	Total	Percentage (1 d.p.)
Total	10	100
Standard	10	100
Colloquial	0	0.0
REAL NAME	6	60.0
given	5	
surname		
full-name		
hypocorism	1	
nick-name		
NON-NAME	4	40.0
pronoun		
title	3	
formal		
kin-term		
solidarity		
leadership		
general noun	1	
occupational		
client		
group		
attitudinal		

As for Lesson C1, colloquial expressions are a feature of the discourse of Lesson C2 as may be seen from Table 8.24. These items function to realise a low level of formality in the tenor relations and ultimately patterns of deference.

Colloquial selections in Lesson C2 such as "come on Gareth, you opened your mouth" (clauses 316-317) may be contrasted to selections in Lesson A such as "Simon you had earlier, when you had your hand up, is there anything you wanted to suggest" (clauses 197-199). These contrasting selections in interpersonal meaning as realised by speech function, MOOD,

modality, the function of the Vocative and lexical choice combine to position students in different worlds. While the students in Lesson C1 and C2 remain firmly tethered to a marginalised position in western culture, students in Lesson A possess the linguistic resources to shift according to the cultural demands of the context of a wide range of situations. This means that the students are capable of shifting from everyday practices to those realising dominant discourses.

Table 8.24 Colloquial expressions

Nature of Colloquial Expression	Total	Percentage (1 d.p.)
	73	100
FIXED EXPRESSIONS	3	4.1
Discoursal - social formula		
Discoursal - structuring		
Catch phrase	2	
Cliche	1	
VARIABLE EXPRESSIONS	70	95.9
General	67	
Anaphoric noun	2	
Attitudinal lexis	1	

Table 8.25 Fixed expressions

Nature of Fixed Expression	Total
	8
VARIETY	
Standard	5
Colloquial	3
Slang	0
CATEGORY	
1. catch-phrase	2
2. cliche	1
3. idiom	
4. proverb	
5. quotation	
6. discoursal	5
social formula	2
structuring	2
comment adjunct	
gambit	
stylistic form	
stereotype	
proverb	1

The incidence and variety of the fixed expressions are given in Table 8.25. Although fixed expressions occur proportionally less often in the discourse of Lesson C2, these items nevertheless function to flavour the interpersonal meaning of the discourse. Expressions such as "come on" (clause 27), "we 'll be here all day" (clause 176) and "close enough is good enough" (clause 201) function colloquially to realise informal relations and patterns of deference. The cases of anaphoric nouns occurring in Lesson C2 are listed below in Table 8.26. Generally the items function to either lower the intensity of the mathematical discourse as in the cases of "things" and the "a better way" (clause 393 and 715) or to create a positive glow as in the case of "right thing" (clause 715). These items lack the interpersonal subtlety of the items which function in other lessons. The strategy of interpersonally favouring the preceding discourse is minimal as revealed by the one case of an anaphoric attribute "easier" (clause 577).

Table 8.26 Anaphoric nouns

Clause No/ Speaker	Clause
393 T*	// you are supposed to ask **things** [like that]
544 T	// there 's **a better way**
545 T	// **a better mathematical word** [[for saying]]
715 T	// then you did **the right thing**

Examples of interpersonal meaning realised through grammatical metaphor are limited in Lesson C2 as may be seen in Table 8.27.

Table 8.27 Grammatical metaphor and interpersonal meaning

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause: **INTERPERSONAL**	
process -----> may	**quality** (nominal group) 652 T // it doesn't give you the other **possible answer** 804 T // that there are two **possible solutions**

The only example found in Lesson C2 is the shift from a Finite realising low modality to Qualifier in the nominal group. In Lessons A and B, however, the shifts involved construction of entities such as "possibility" while in Lesson C1 grammatical metaphors realising interpersonal meaning were absent.

8.232 Tenor

The tenor relations in the oral discourse of Lesson C2 realise patterns of deference which are reminiscent of those found in Lessons B and C1. However, differences exist between these lessons with respect to the emphasis directed towards interpersonal meaning and the prominence of particular strategies in relation to others.

I believe that due to the relatively simple tasks which the students engage with in Lesson C2, interpersonal meaning does not dominate the lesson as a strategy for the control of potential unrest. The lesson is structured so that small advances are made in an orderly fashion with the development of the theory largely left in the hands of the teacher. That is, the strategies of control are built into the structure of the lesson, as opposed to depending on interpersonal brute force. The students do not offer resistance, as is revealed by the nature of the student interruptions. However, as I demonstrate in the remainder of this chapter, the practical nature of the lesson impinges on experiential and logical meaning with the result that structures typical of the pedagogical discourse of mathematics are absent in the discourse of Lesson C2.

With the exception of the interpersonal congruence realised through MOOD selections of the teacher commands, patterns of deference are manifested through paralinguistic behaviour, chorus responses, minimally extended student contributions, ellipsis and colloquial selections. Interpersonal metaphor is realised through tagged declaratives and plays with modality.

The interpersonal congruence of the teacher commands replicates the patterns found in Lesson A. As I have previously suggested, there are two possible explanations for this phenomenon. Firstly, the eminence of the step-like structures realised in the microgenres of Lesson C2 leads to interpersonal congruence as for other genres which realise sets of

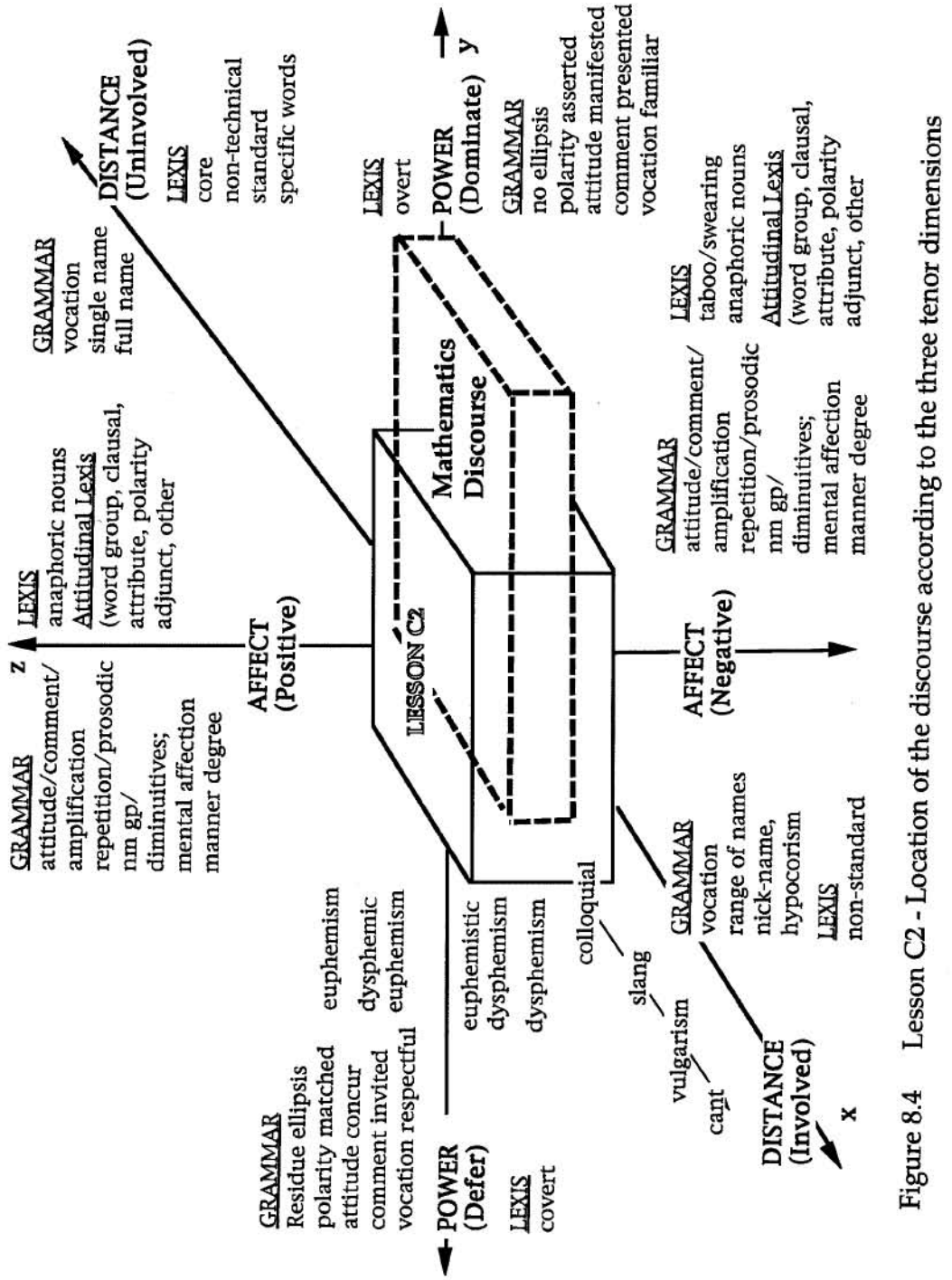


Figure 8.4 Lesson C2 - Location of the discourse according to the three tenor dimensions

instructions. Secondly, the relative equality of the social status of the teacher and students may be such that metaphor is not required to camouflage the hierarchy as found between the male teacher and female students in Lesson B and the male teacher and working class students in Lesson C1. What differs between Lessons A and C2, however, is the relative position which is realised on the hierarchical social scale. The dominating patterns in each dimension of the interpersonal relations of Lesson A suggest that these interlocutors are located in the premier position of the social scale while the patterns of deference suggest that the interlocutors in Lesson C1 are located at the opposite end of the spectrum.

As opposed to the covert strategies of control realised in Lesson C1, lexical items and paralinguistic behaviour function to realise surges of interpersonal meaning in the form of colourful displays which promote enthusiasm for the work in hand. Although items such as "amazing" are tongue-in-cheek, the discourse is peppered to promote interest through such linguistic choices. The colloquial nature of the discourse realises involved contact and affect is manifested though amplification and paralinguistic selections. Although the teacher coaxes and encourages the students on several occasions, covert selections such as "dummies" (clause 23) function to reinforce a marginalised position.

The location of the tenor relations of Lesson C2 with respect to mathematical discourse is represented in Figure 8.4. As may be seen from this display, the position does not accord with the power dominating relations of mathematical discourse.

8.233 The Mathematical Text

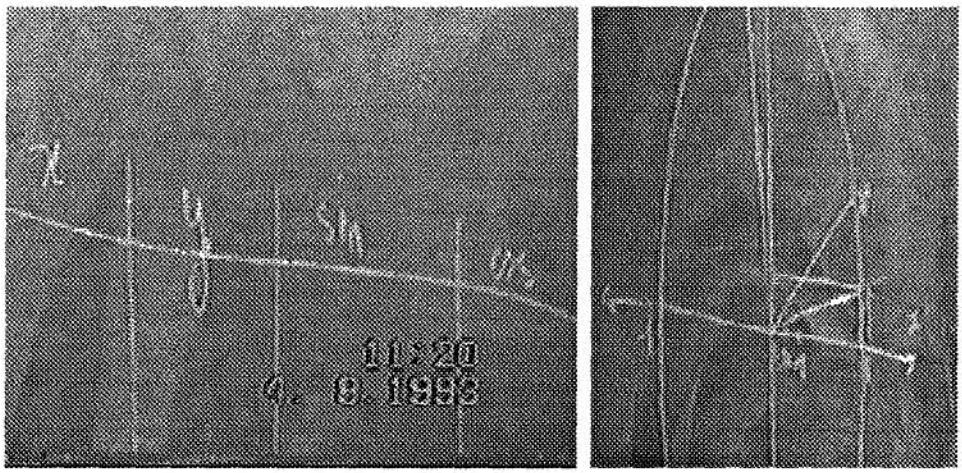
The following views of the board text illustrate general features of the display and reinforce my proposal that features of the oral discourse are replicated in the visual texts. Most significantly, features of the oral discourse realise a marginal position with respect to mathematical discourse. This position is reflected in the non-generic forms of representation realised in the board text.

Despite consisting of graphs, diagrams, tables and constructed triangles, the complete board text is drawn freehand in Lesson C2. In addition, although

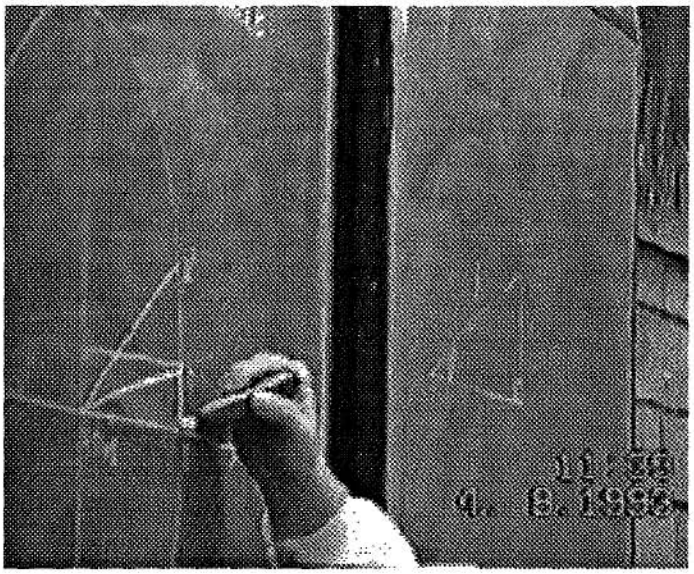
not obvious in these displays, we may note that colour is not employed to realise interpersonal meaning in the board texts of Lesson C2.

In Scene 8.1, the table and graph are drawn without the aid of a ruler or compass. As such, the displays do not replicate the genres of mathematical texts. Rather than power dominating relations, the style of production emulates a position of deference through the lack of precision of the lines and circle.

Scene 8.1 The board text - View 1



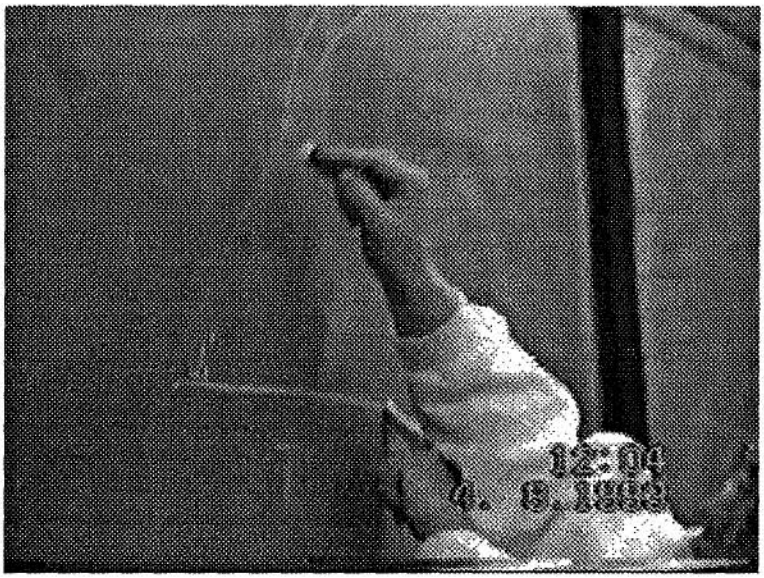
Scene 8.2 The board text - View 2



In Scene 8.2 above, the teacher draws the graph without the aid of a ruler. On the right hand side of the frame, this style of production is also found in the diagram of a right triangle.

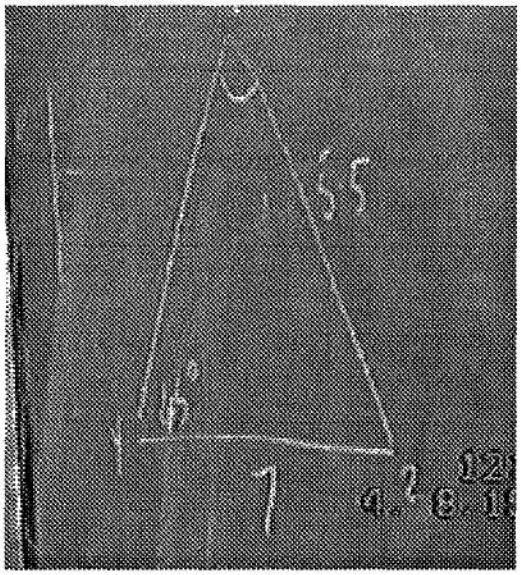
The freehand style of the visual display extends to drawing arcs for the construction of the triangle as displayed in Scene 8.3. In this view, the teacher is imitating the use of a compass to draw two intersecting arcs with the point of intersection giving the vertex of the triangle. Once again, these techniques result in representations which do not accord with the generic practices of mathematics.

Scene 8.3 The board text - View 3

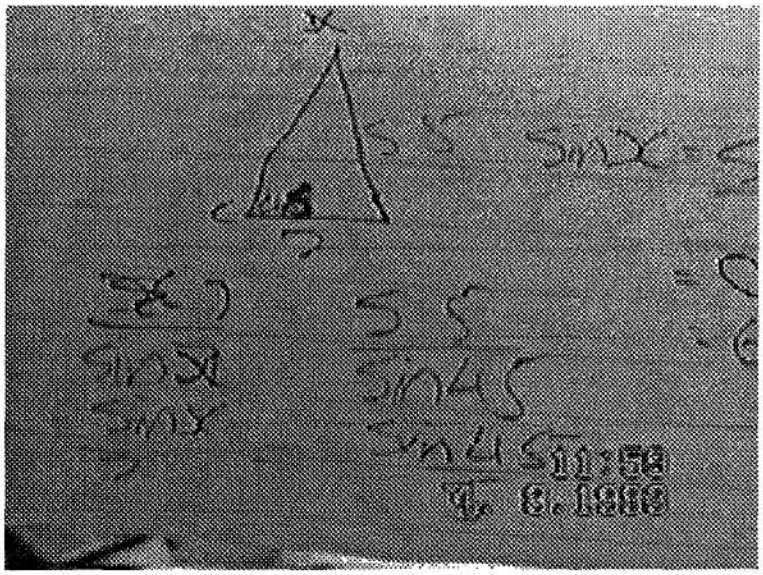


The freehand style of production has significant impact on the student reproductions of the board texts as seen in the next two frames. The board text of the example is given in Scene 8.4 while a student's representation of that same board text is given in Scene 8.5. As may clearly been seen in this example, the students faithfully replicate the features of the board text. This serves to illustrate the point that the students in Lesson C2 are not constructing generic forms of representation. As a result, generic mathematical texts may appear daunting to these students who are so clearly marginalised from the discourse of mathematics.

Scene 8.4 The board text - View 4

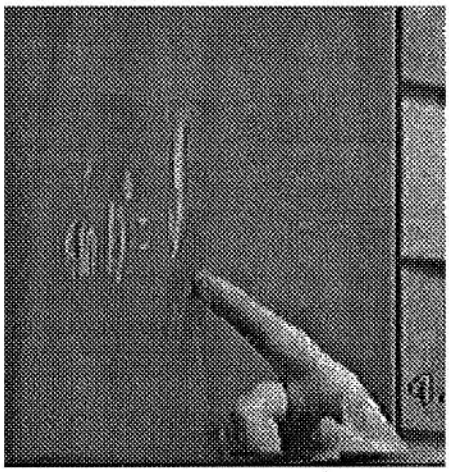


Scene 8.5 Student text - View 5



Finally, as for each lesson, the role of gesture is crucial in realising interpersonal meaning. As captured in similar views for the other lessons, in Scene 8.6 the teacher directs attention through pointing at a particular part of the board representation. In this example, the arrangement of the teacher's fingers, especially the extended index finger, realises a high value of modality.

Scene 8.6 The board text - View 6



The complete board texts are displayed below in Figure 8.5. According to the classification of mathematical genres given in Chapter 4, the texts #A, #C and #D are 'storing information' genres in the form of reports while texts #B, #E and #F are 'solving problems' genres consisting of mathematical problems and solutions.

The remainder of this section is devoted to making general observations concerning the interpersonal meaning of these texts.

Modally the teacher focuses attention through the capitalised letters of the heading "SINE RULE". Following this, although the table and graph displayed as #C appear to be full of information, it should be remembered that these texts are developed slowly in the context of the lesson.

#A

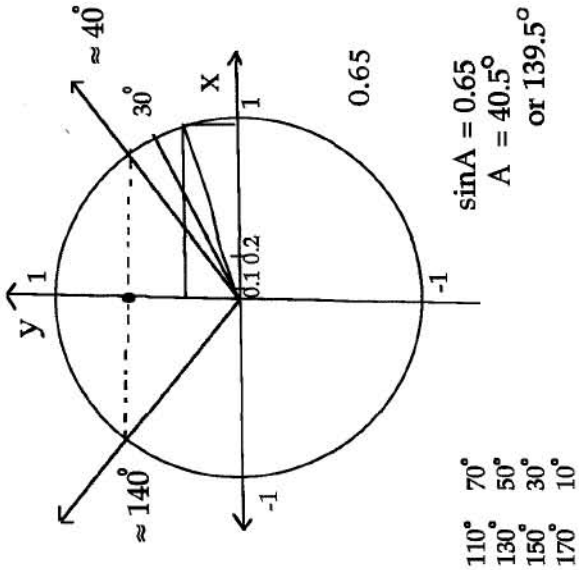
SINE RULE

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

#B

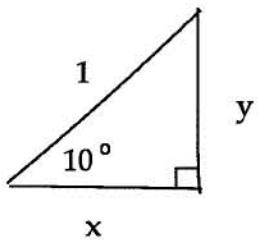
X = 64 ?

#C



Angle	x	y	sin	cos
10°				
30°				
50°				
70°				
100°	-ve	+ve		
110°				
130°				
150°				
170°				

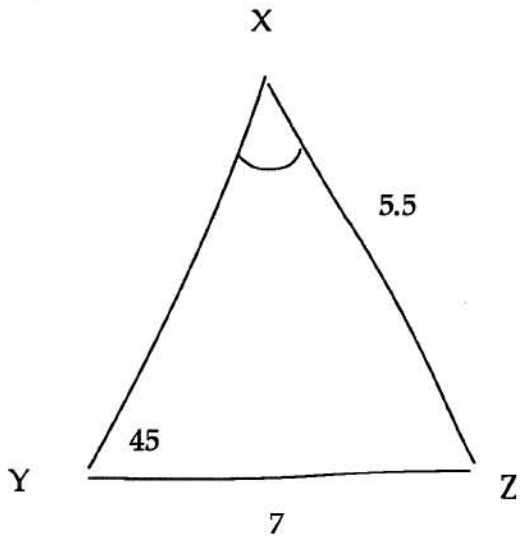
#D



$$\sin 10° = \frac{y}{x}$$

$$\cos 10 = \frac{x}{}$$

#E



$$\frac{x}{\sin X} = \frac{y}{\sin Y}$$

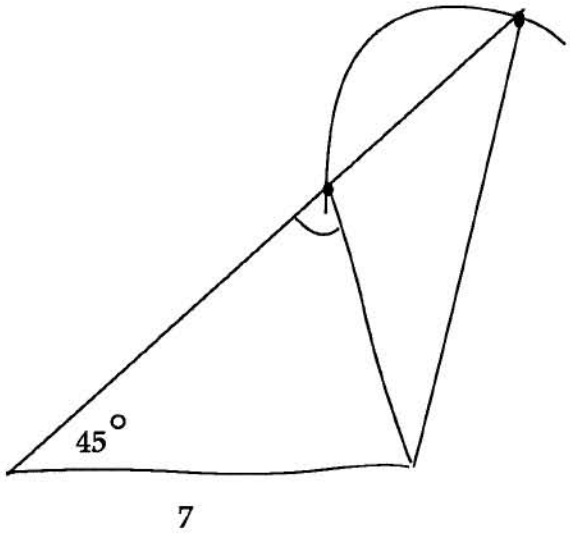
$$\frac{7}{\sin X} = \frac{5.5}{\sin 45}$$

$$\frac{\sin X}{7} = \frac{\sin 45}{5.5}$$

$$\sin X = 0.8999 \ldots$$

$$X = 64° \text{ or } 116°$$

#F



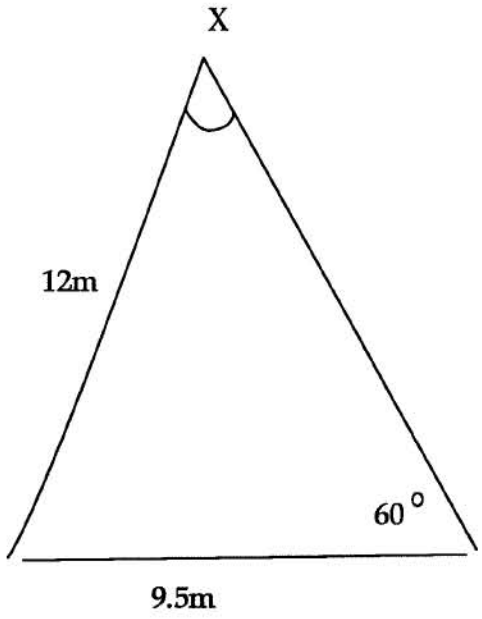


Figure 8.5 The board text

In the graph the axes frame the unit circle while intersecting to create the centre of the display at the origin. The symmetry of the visual display occurs as this point is also the centre of the circle. From this central point, the viewer's gaze spreads outwards as directed by the arrows on the rays that

depict the angles. The labels "x" and "y" focus attention as does the scale on the x-axis, the points of intersection of the circle and the axes labelled as "1" and "-1" and the size of the angles marked as "$\approx 140^{o}$" and "$\approx 40^{o}$". The horizontal dashed line signifies its secondary importance compared to the filled lines. The intersection of this line with the y axis, however, is modally marked with a filled dot.

With respect to the table, the viewer's gaze is directed by the freehand lines. The heading of each column is framed by these lines and thus given prominence. The arrows modally link "x" with "cos" and "y" with "sin". Also the angle measurements are divided into two sets through the second horizontal line.

The texts marked #D and #E are interpersonally marked by the inaccuracy of the freehand lines which gives the image of almost childish drawing. In #E in particular, the line segments do not intersect at a point while the marking of angle X appears amateurish especially if compared with the board presentation of Lesson A. Underneath, the symbolic solution appears in generic form though the writing does not match the professional quality of that found in Lesson A. The features of the triangle in #E are replicated in the depiction of the construction of the triangle in #F. Further to this, the amateur production is accentuated by the freehand drawing of the arcs.

In summary, the interpersonal meaning of the board text accords with the tenor relations realised in the oral discourse. That is, the style of production and modal strategies realise patterns of deference as opposed to the power dominating position of generic mathematical visual texts. The wavering lines and lack of precision of the board text and low modality do not accord with mathematical discourse. As the student text displayed in Scene 8.5 above demonstrates, these patterns are replicated by the students in their representations of the board text.

8.24 Textual Meaning

8.241 General Lexicogrammatical Patterns, IDENTIFICATION and Textual Metaphor

The Theme selections for the oral discourse of Lesson C2 are summarised in Table 8.28.

Table 8.28 Classification and components of Theme selections

	Total	Percentage
	665	100
CLASSIFICATION OF THEME		
Unmarked	431	64.8
Marked	28	4.2
Dependent	27	4.1
Embedded	8	1.2
Ellipsed	124	18.6
No theme (minor clause)	42	6.3
Unknown	5	0.7
NATURE OF THEME		
No Thematic components		
Ellipsed topic	110	16.5
Minor clause or Non-finite Independent Clause	33	5.0
Single Theme		
Ideational only	299	45.0
Multiple Theme	218	32.8
1. Ideational component	195	
Ideational/Textual	151	
Ideational/Textualx2	24	
Ideational/Textualx3	5	
Ideational/Interpersonal	11	
Ideational/Textual/Interpersonal	3	
Ideational/Textualx2/Interpersonal	1	
2. No Ideational Component		
a. Ellipsed Topic	(14)	2.1
Textual	12	
Textualx2	2	
b. Minor/Non-finite Dependent Clauses	(9)	1.4
Textual	4	
Textualx2	1	
Textualx3	1	
Interpersonal	1	
Textual/Interpersonal	2	

Lesson C2 has a relatively high incidence of unmarked Themes and a low incidence of marked Themes. Unlike the more formal discourse of Lesson A, thematic strategies for foregrounding selected meanings are not employed in the discourse of Lesson C2. In addition, as for Lesson C1, the proportion of ellipsed Themes reflects the colloquial nature of the discourse.

The highest incidence of ellipsed topics and single Themes is found in Lessons C1 and C2 together with the lowest incidence of multiple Themes. With respect to the components of multiple Themes, on average 2.7% of clauses (18 items) contain interpersonal components and 37.0% (246 items) contain textual components. The number of interpersonal components is significantly lower than other lessons which is a reflection of the lack of Vocatives. The percentage of textual components is comparable to Lesson B and greater than Lesson C1.

In summary, the relative position of each lesson in terms of a descending scale of sophistication with respect to textual organisation as revealed by the nature and components of the Theme is: Lesson A, Lesson B, Lesson C1/Lesson C2.

Table 8.29 Field of theme

FIELD	Total	Percentage (1 d.p.)
	494	100
Teacher	31	6.3
Students	77	15.6
Teacher and students	47	9.5
TOTAL	155	31.4
Mathematical lexical item	64	13.0
Mathematics (WH-item)	48	9.7
Mathematics (TH-item)	25	5.1
Maths (pronoun)	52	10.5
Related to Mathematical classwork	29	5.9
TOTAL	218	44.1
Student work	0	0.0
Action	69	14.0
Other	52	10.5

The nature of the field of the Theme is given above in Table 8.29. The teacher and students form the lowest percentage found in the four lessons possible due to the large number of commands which are congruently realised as imperatives. This is reflected in the relatively high incidence of Themes that have been categorised as 'Action'. As for Lesson A, Themes

pertaining to the mathematical content feature as the point of departure for the message, with the difference being that in Lesson C2 pronouns are chosen more often than mathematical lexical items. The lexical non-specificity of the discourse of Lesson C2 is further explored in the reference patterns below. Regardless of this feature, the nature of the Theme indicates that the central concern of Lesson C2 is the mathematical content.

Table 8.30 Clausal and phrasal rankshift

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	662	100
Rankshifted Clausal Element (Total)	57	8.6
Rankshifted Clause and Phrase Elements	25	3.8
Rankshifted Phrase Only	142	21.5

Table 8.31 Clausal and phrasal rankshift: Teacher and student contributions

	Teacher		Student	
	Total	% (1 d.p.)	Total	% (1 d.p.)
CLASSIFIED CLAUSES (Total 662)	535	80.8	127	19.2
RELATIVE PERCENTAGE	535	100	127	100
Rankshifted Clausal Element - Total	55	10.3	2	1.6
Rankshifted Clause and Phrase Elements	24	4.5	1	0.8
Rankshifted Phrase Only	129	24.1	13	10.2

Table 8.32 Clausal and phrasal rankshift: Private interactions

	Total	Percentage (1 d.p.)
CLASSIFIED CLAUSES	55	100
Rankshifted Clausal Element (Total)	3	5.5
Rankshifted Clause and Phrase Elements	1	1.8
Rankshifted Phrase Only	7	12.7

The low incidence of rankshifted clausal elements and high incidence of phrasal elements as displayed in Table 8.30 above reflects the field of the discourse in Lesson C2. That is, the lack of algebraic expressions and the emphasis on the visual display in the form of tables, graphs and diagrams accounts for the proportion of clausal and phrasal rankshifted elements respectively. As may be seen in Table 8.31 and Table 8.32, student

contributions and private interactions which contain either of these elements are minimal.

An example of some major reference chains is given below in Figure 8.6. As shown, there are constant shifts between the oral and visual modes with the constitutive and ancillary codes alternating between language, diagrams, mathematical symbolism and gesture. Thus the oral and visual participant chains intertwine. Several features of these reference patterns deserve special mention.

Firstly, the mathematical participants are often realised by non-technical terms such as "the top bit" and "this bit", TH-items such as "that" and general pronouns such as "it" which are repeated on many occasions. This pattern of lexical non-specificity replicates that found in Lesson C1. As such it appears to be a feature of a restricted code. This means that the role of gesture and the system of Deixis is particularly important in the tracking of participants in Lesson C2. While making the discourse accessible through the simplicity of the reference selections, the result, however, is that shifts from everyday discourse to mathematical discourse are somewhat limited with respect to textual organisation. As I demonstrate in this chapter, this observation extends to each dimension of meaning.

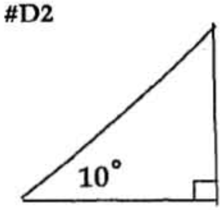
Secondly, although the chains split and cojoin as the participants in the diagram and the graph are linked to form symbolic participants, the patterns are simple when compared to those found in Lesson A. The major reason for this simplicity is the absence of rankshifted nuclear configurations involving Operative processes and the reference selections for mathematical participants. As discussed in relation to the experiential meaning of the discourse in section 8.251, the nature of the lesson and the reliance on visual display results in discourse which lacks the characteristics of mathematical pedagogical discourse as realised in Lesson A. In the excerpt analysed in Figure 8.6, the teacher is establishing the connections between the results of the practical activity and the definition of sine and cosine from the right triangle. These definitions result in mathematical statements which are symbolically expressed. While the participants of the right triangle are related to participants in the graphical display and the relationship between them is symbolically expressed, the reference patterns remain relatively simple because of the lack of rankshift in the symbolic representation.

CONSTITUENT MODE: Aural (linguistic)
ANCILLARY MODE: Visual (diagram/gesture)

291 T	// what information do we know [about the right angled triangle [[we made]]]
292 S?	// the top bit is ten degrees
293 T	// we know
294 T	// that this angle here is ten degrees

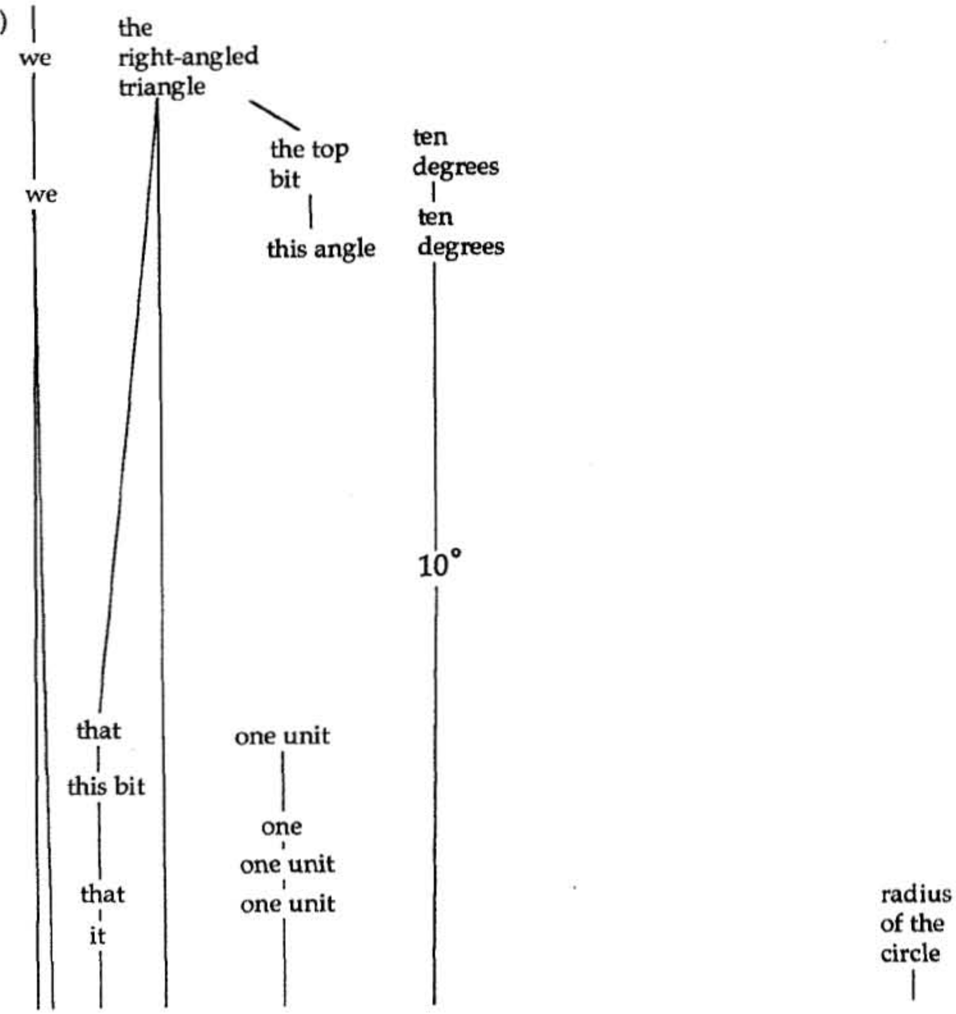
CONSTITUENT MODE: Visual (diagram)

#D2



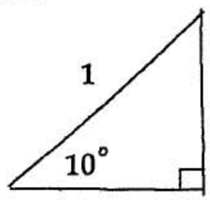
CONSTITUENT MODE: Aural (linguistic
ANCILLARY MODE: Visual (diagram/gesture)

295 S1*	// that 's one unit
296 T	// how long is this bit
297 Ss	// one
298 Ss	// one unit
299 T	// that 's one unit
300 T	// cause it 's the radius [of the circle] isn't it
301 S?	// mmm



CONSTITUENT MODE: Visual (diagram)

#D3

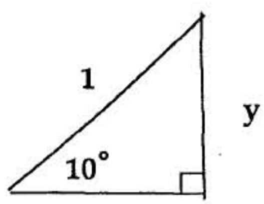


CONSTITUENT MODE: Aural (linguistic)
ANCILLARY MODE: Visual (diagram/gesture)

302 T	// what do I know [about this length]	I	1	this length	
303 T	// how can I describe that length there	I		that length	
304 S?	// it 's the same [as the one [on the 'y]]			it	the one [on the 'y']]
305 T	// it 's the same [as the little bit [of the 'y']] isn't it			it	the little bit
				that	y number

CONSTITUENT MODE: Visual (diagram)

#D4



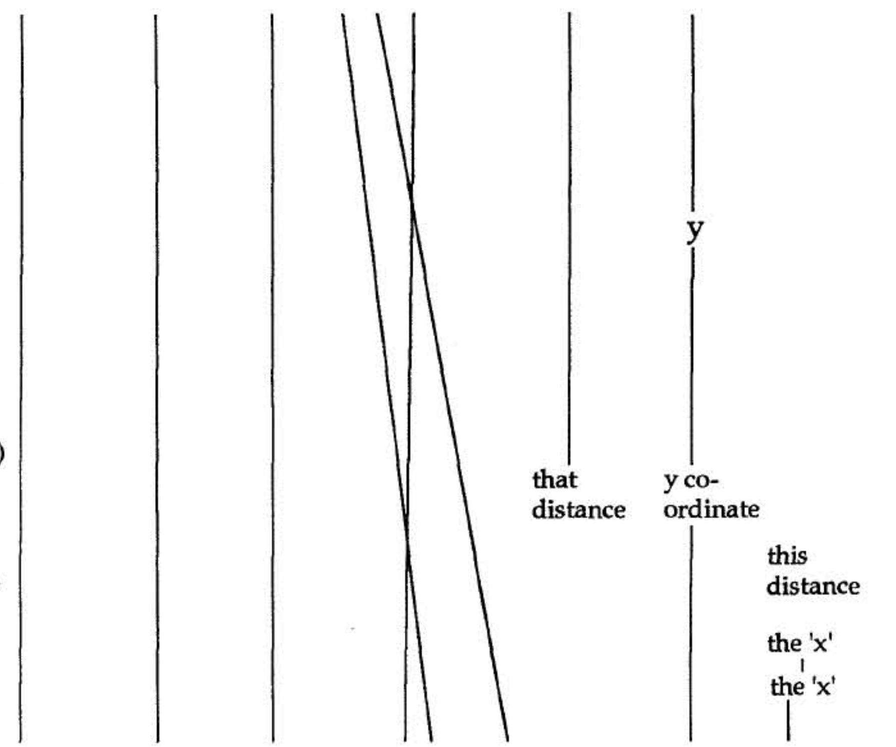
CONSTITUENT MODE: Aural (linguistic
ANCILLARY MODE: Visual (diagram/gesture)

307 T // that distance there is the same [as the 'y' coordinate]

308 T // OK what [about this distance] here

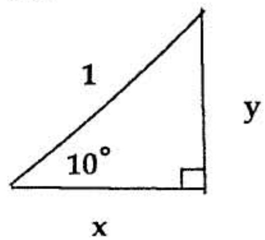
309 S? // same [as the 'x']

310 T // it 's the same [as the 'x']



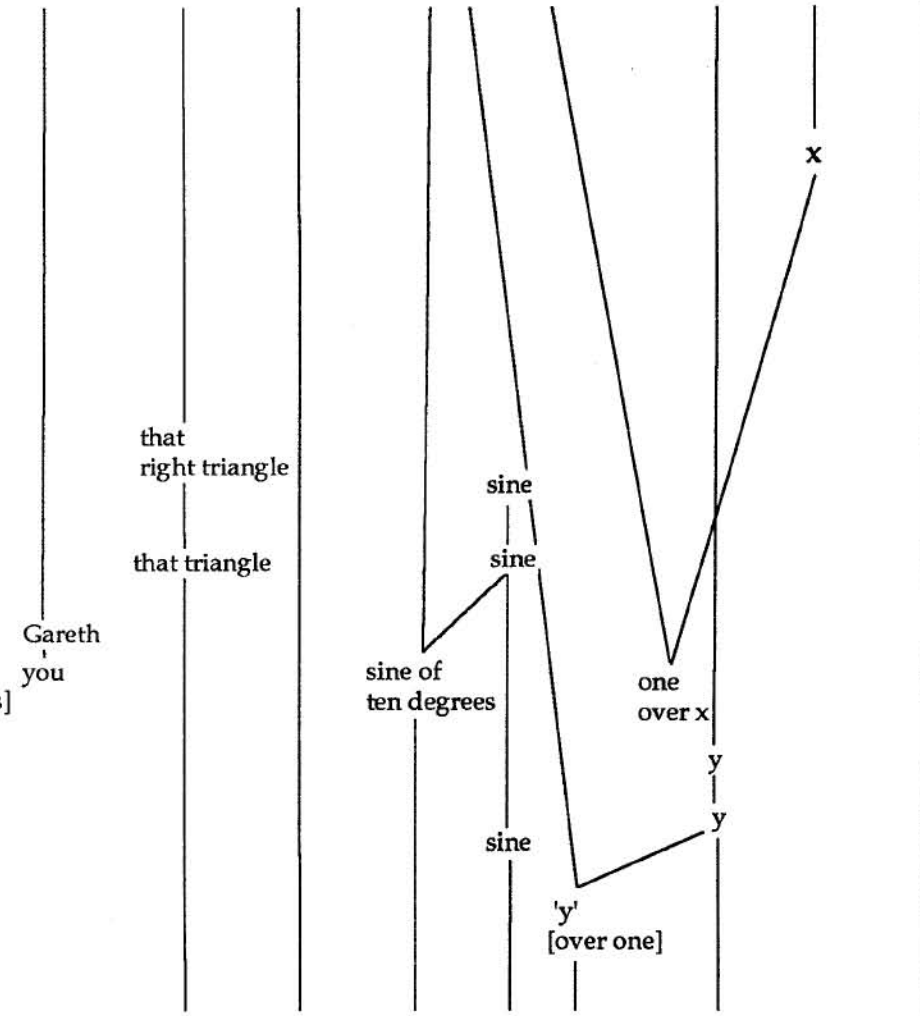
CONSTITUENT MODE: Visual (diagram)

#D5



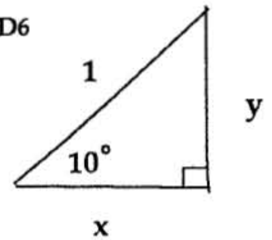
CONSTITUENT MODE: Aural (linguistic)

311 T	// OK using that right triangle
312 T	// make up an equation [for sine]
313 T	// what now
314 T	// an equation [for sine] there [for that triangle]
315 T	// any suggestions
316 T	// come on Gareth
317 T	// you opened your mouth
318 Gar	// oh OK umm sine [of ten degrees] equals one [over 'x']
319 S?	// no
320 Gar	// 'y' sorry
321 S?	// 'y'
322 T	// sine is
323 Gar	// sorry
324 Gar	// 'y' [over one]
325 T	// 'y' [over one]
326 Gar	// wrong order



CONSTITUENT MODE: Visual (symbolic)

#D6



$$\sin 10^\circ = \frac{y}{1}$$

CONSTITUENT MODE: Aural (linguistic)

327 T	// 'y' [over one] is just
328 Ss	// 'y'

CONSTITUENT MODE: Visual (symbolic)

#D7

$$\sin 10^\circ = y$$

CONSTITUENT MODE: Aural (linguistic)

329 T	// 'y'
330 T	// so the sine [of the angle] is equal to the same number [as the 'y' co-ordinate [in a unit circle]]
331 T	// because the radius is one

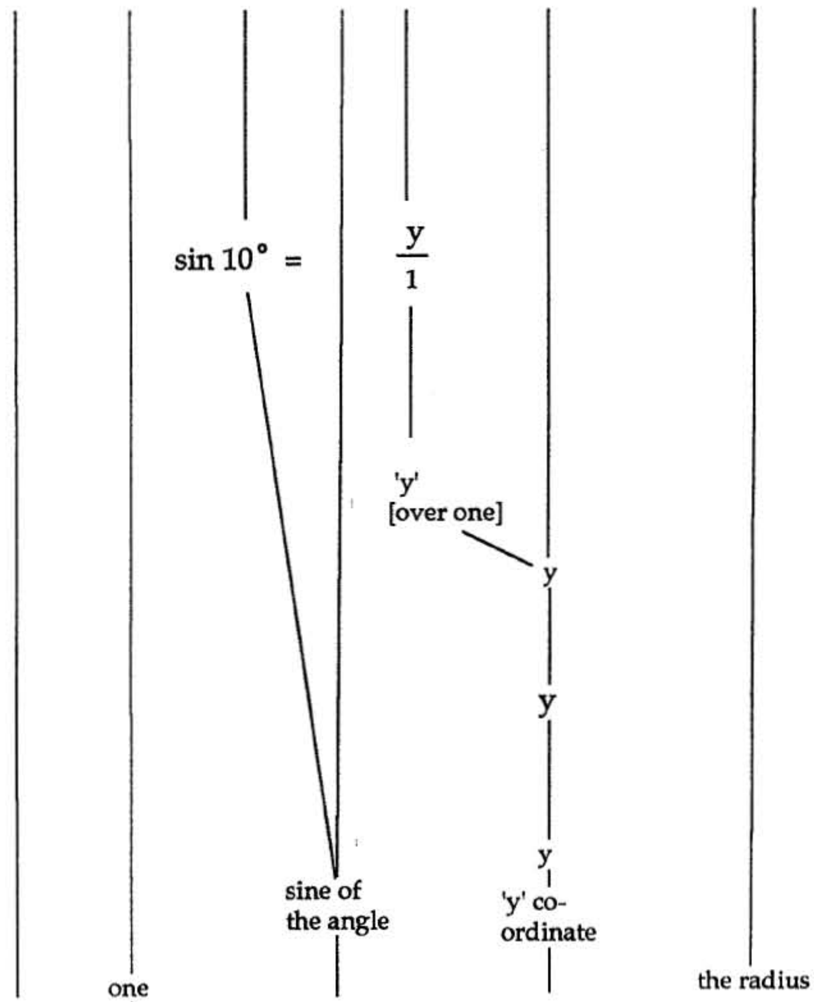


Figure 8.6 An example of the major reference chains

With respect to textual metaphor, the 'meta-message' relations realised through anaphoric nouns are not pronounced in Lesson C2. As previously discussed, although several cases do occur, they lack the subtlety of those found, for example in Lesson A. Secondly, examples of text reference occur in conjunction with the review of previous work, new content of the lesson and student answers as illustrated by the following examples. As these patterns stretch across each of the lessons, text reference appears to be a feature of mathematical pedagogical discourse. Substitution is a major vehicle for anaphoric reference because it allows for whole episodes of discourse to be referred to and because it allows for multiple coding which is difficult to refer to by single reference items.

46 T // can you remember **that**
254 T // OK **that** 's pretty obvious <<isn't it>> [from the table]
393 T* // you are supposed to ask things [like **that**]
459 T* // yeah **that** does work
543 T // no there 's another way [[of saying **that**]] isn't there

In addition, negotiating texture operates through selection of the collective "we" and the second order imperative Subject "let's".

With these limited strategies of textual metaphor, Theme selections and simplicity of reference, the textual organisation is not as sophisticated as that of Lesson A. Further to this, as will be seen in section 8.26, there is a lack of internal Conjunctions which organise rhetorical arguments.

8.242 Mode

Given the centrality of the microgenres of Practical Activity and Practical Activity Discussion, the discourse of Lesson C2 realises constant shifts between the oral and visual modes. The nature of the reference patterns means that gesture and selections from the system of Deixis play a significantly more important role than in Lesson A. As for Lesson C1, the non-technical lexical selections and pronouns mean that tracking involves a heavy reliance on visual as opposed to linguistic cues.

At this stage, I would like to point out that a reliance on visual cues such as gesture for textual organisation has two significant consequences. Firstly, the students would find it extremely difficult to revisit this text. Secondly, the students may experience difficulties in penetrating the written discourse of

mathematics. With the absence of board notes and generic forms of textual organisation, the students are not being inducted into the discourse of mathematics.

8.243 The Mathematical Text

The textual organisation of the board text as viewed from the discourse stratum of the reference chains is complex, as revealed in Figure 8.7 below. This complexity arises from the use of multiple visual displays in the form of the table, the graph, the diagram and mathematical symbolism. The spatial positioning of these texts in the representation in Figure 8.7 replicates that realised on the blackboard. I would like to note that the display of reference patterns is not comprehensive given the intricacy of the display.

As indicated by the arrows, the reference is largely anaphoric, though given the spatial position of each part of the visual display, the arrows do not point upwards, but rather stretch across the display. At the centre is the graph through which participants are largely presented. Exceptions include "sin" and "cos" which are presented in the table. With this exception in mind, the participants in the table and diagram of the right triangle are presumed from the graph while the participants in the symbolic text refer to the participants in the diagram which in turn are presumed from the graph. The crucial role of the graph is further explored with respect to experiential meaning in section 8.253.

The complexity of the reference chains arises as the result of tracking participants across the different visual displays. Although inter-connections are established through symbolic labels, as seen in the display, tracking is nevertheless intricate. Within each part of the visual display, however, textual meaning is realised through strategies which are specific to that genre.

In the table the headings organise the information in each column through spatial positioning and framing. The hypo-Theme may be conceptualised as the heading of each column, with the Themes spatially positioned underneath. As Lemke (forthcoming) comments, the table is the most extreme form of textual organisation arising from linguistic texts. As a feature of the grammar of mathematical symbolism, in the symbolic text

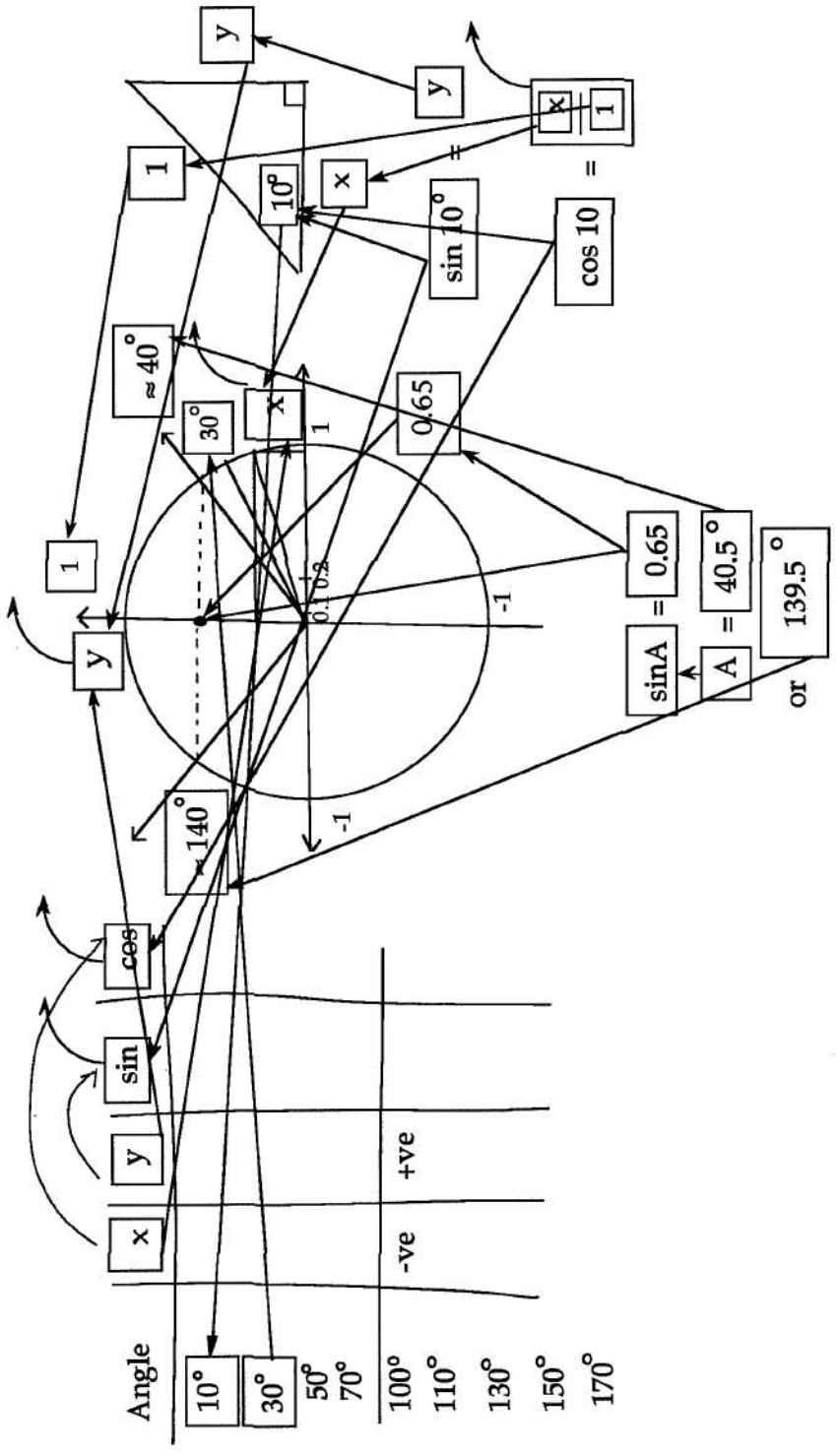


Figure 8.7 Major reference chains in the board text

realising the solution of "sin A = 0.65", spatial positioning aids tracking. In the graph the framing of the set of axes with the unit circle provides a stable base for offsetting the dynamic display of the angle size. In addition, the labels provide discursive links to the table and the diagram. In the diagram the right triangle is formed from the axes and ray representing the ten degree angle in the graph. Although these links are established through labels, in view of the different positioning of the corresponding lengths of the sides in the triangle and graph, the tracking of these participants is not immediately apparent. In addition, the angle size of ten degrees appears only in the table and not in the graph. Nevertheless, in the diagram once more, stability is created through the horizontal and vertical sides of the triangle with the diagonal hypotenuse presenting the dynamic display of the size of the angle.

Although in the context of the oral discourse, the participants may be tracked with the aid of visual cues such as gesture, it would be extremely difficult to revisit this text. In the absence of an accompanying written linguistic text, the textual organisation arising from the co-deployment of different visual genres means that not only are participants difficult to track, but once again students are not being prepared to access or construct mathematical texts.

8.25 Experiential Meaning

8.251 General Lexicogrammatical Patterns, IDEATION and Experiential Metaphor

The processes types selected in Lesson C2 are summarised below in Table 8.33. While Material and Relational Attributive processes feature in the oral discourse of Lesson C2, the most striking deviation from the patterns found in other lessons is the lack of Operative processes in both the ranking and non-ranking clauses. The most obvious explanation for this lack of Operative processes is the practical orientation of the lesson and the reliance on visual depiction. That is, in Lesson C2 the students are not engaging in constructing reality through the use of the semiotic code of mathematical symbolism but rather are engaging in concrete manipulative practices involving visual display in the form of diagrams, graphs and tables. As a compounding factor, Operative processes are realised metaphorically while other lexical selections involving, for example, the use of the Sine Rule for solution of the triangle, mean that the typical patterns of multiple rankshifted Operative processes are not found in the discourse of Lesson C2.

These patterns are illustrated in the following excerpt where the teacher is using the Sine Rule to find the values for angle X. Rather than Operative processes of multiplication and division between mathematical participants, Material processes are selected.

701 T // [[what we want [[to find]]]] is [in the bottom part of the fraction]
702 T // what do we do [with the fraction]
703 Ss // turn them [upside down]
704 T // turn them both [upside down]
705 T // whoops [upside down]

Table 8.33 TRANSITIVITY: Process selections

	Major Clauses		Rankshifted Clauses		Overall Totals	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
Processes	563	100	74	100	637	100
MATERIAL	154	27.4	21	28.4	175	27.5
MENTAL	106	18.8	15	20.3	121	19.0
Cognition	68		6			
Perception	32		6			
Affection	6		3			
RELATIONAL - ATTRIBUTIVE	148	26.3	25	33.8	173	27.2
Intensive	76		9			
Circumstantial	37		4			
Possessive	35		12			
RELATIONAL - IDENTIFYING	86	15.3	6	7.1	92	14.4
Intensive	79		4			
Circumstantial	7		2			
Possessive	0					
OPERATIVE	11	2.0	1	1.4	12	1.9
VERBAL	43	7.6	3	4.1	46	7.2
BEHAVIOURAL	5	0.9	2	2.7	7	1.1
EXISTENTIAL	10	1.8	1	1.4	11	1.7

This means that the discourse of Lesson C2 lies outside the margins of that typically found in mathematical pedagogical discourse. The value of practical lessons and concrete activities are often touted in the literature of

mathematics education, but in view of the nature of the constructions of reality which result and their distance from mathematical reality as semiotically constructed through mathematical symbolism, one could question the merit of extended programs based on this approach. It appears that while students experience levels of success in practical activities, there are limits to the functionality of such lessons. That is, while they make the mathematical ideas intuitively accessible, students nevertheless still need to make the transition to mathematical discourse which necessarily realises different lexicogrammatical strategies and structures. In Lesson C2, the oral discourse as reflected in the textual and experiential meaning remains firmly embedded in everyday discourse. As will be seen, these patterns extend to the logical meaning realised in the oral discourse. Given the location of the discourse, perhaps the limitations of Lesson C2 are encapsulated in the following teacher comment.

241 T* // you like this do you
242 T* // you can do it

The patterns of Voice selections are displayed in Table 8.34. As for each lesson, the majority of the clauses are 'middle' as opposed to 'effective' despite the practical orientation of the lesson. This is explained by the activities performed over a certain Range as opposed to a causative process involving another participant.

Table 8.34 Voice

	Ranking Clauses	Percent-age	Rank-shifted	Percent-age	Total	Percent-age
CLASSIFIED CLAUSES	503	100	74	100	577	100
EFFECTIVE 1. Active Agent Ellipsed Agent 2. Passive	93 89 88 1 4	18.5	9 8 8 1	12.2	102	17.7
MIDDLE (Active) Medium Ellipsed Medium	309 303 6	61.4	46 46	62.2	355	61.5
3. NO VOICE	101	20.1	19	25.7	120	20.8

The nature of the processes that are metaphorically realised is summarised in Table 8.35. As may be seen, these consist largely of metaphorical Mental

processes and to a lesser extent Operative processes. In the former case, Material processes such as "had to use" (clause 34), "to find" (clause 41) and "count" (clause 117) metaphorically realise Mental processes.

Table 8.35 Metaphorical processes

	Major Clauses		Rankshifted Clauses		Overall Totals	
	Total	Percent-age	Total	Percent-age	Total	Percent-age
Processes	22	100	10	100	32	100
MENTAL	20	90.9	3	30.0	23	71.9
Cognition Perception Affection	20		3			
OPERATIVE	2	9.1	7	70.0	9	28.1

The cases of metaphorically realised Operative processes are listed in Table 8.36. The metaphorically realised processes consist entirely of the process of division being realised as "over". As discussed in Chapter 5, this is a case of semiotic metaphor whereby the lexicogrammar of mathematical symbolism allows for spatial position to realise the Operative processes. In this case, in the shift to language, the process of division is realised as Circumstance through the preposition "over".

Table 8.36 Examples of metaphorical Operative processes

Clause N°/ Speaker	Rank	Process	Participants
44 T	(3a)	[over	X1= [['a' X2= sine A]
44 T	(4a)	[over	X1= 'c' X2= sine C]]]
318 Gar	(2a)	[over	X1= one X2= 'x']
324 Gar	(1a)	[over	X1= 'y' X2= one]
325 T	(1a)	[over	X1= 'y' X2= one]
327 T	(2a)	[over	X1= 'y' X2= one] is just
334 S?	(2a)	[over	X1= 'x' X2= one]
335 T	(2a)	[over	X1= 'x' X2= one]
336 T	(2a)	[over	X1= one]

Examples of grammatical metaphor realising experiential meaning are listed in Table 8.37. As may be seen, in Lesson C2 the range of such metaphors is limited to those realising a shift from process to entity. This indicates that experiential meaning tends to be congruently realised in Lesson C2. This trend extends to each dimension of meaning in Lesson C1 and C2. This places the lexicogrammatical and discourse strategies of the oral discourse of these lessons firmly outside that realised in written discourse.

Table 8.37 Grammatical metaphor and experiential meaning

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause: EXPERIENTIAL L	
process ----->	**entity** **'Thing' in nominal group**
inform	37 T // you worked out **what information** [[you wanted [[to find]]]]
equate	312 T // make up **an equation** [for sine]
suggest	315 T // **any suggestions**
assume	404 T* // once you 've made **some sort of assumptions**
solve	804 T // that there are **two possible solutions**

The nature of the mathematical register items is listed below in Table 8.38. With Lesson C1, the percentage of non-technical terms is the highest found in the lessons analysed in this study. Further to this, the percentage of technical terms is the lowest, indicating that the oral discourse of Lesson C1 and C2 is furthest placed from the formal discourse of mathematics.

As for each lesson, the majority of lexical items are nominal groups. We may note that the incidence of selections from the system of Deixis is the highest found in any lesson. This is a reflection of the reference patterns previously discussed. In addition, Numeratives, Classifiers and Qualifiers are realised in nearly equal proportions. This reflects the use of visual display in the form of the graph and the triangle in combination with the

semiotic code of mathematical symbolism. On the other hand, however, few mathematics register items are realised as rankshifted clauses and verbal groups. Given the central role of the diagram and graph, however, with Lesson A the largest ratio of register items realised as prepositional phrases is found in Lesson C2.

Table 8.38 Classification of mathematical register items

	Total	Percentage
CLASSIFICATION	557	100
Technical	355	63.7
Jargon	26	4.7
Non-technical	176	31.6
ELEMENTS	568*	100
Clausal	11	1.9
Nominal	351	61.8
Group		
Thing	306	
ellipsed Thing	45	
Deictic	202	
Epithet	17	
Numerative	73	
Classifier	63	
Qualifier	63	
Verbal	51	9.0
Group	39	
Event	39	
Finite	12	
Polarity		
Auxiliary	1	
Phrase	12	
Event	12	
Finite	3	
Polarity		
Auxiliary	1	
Prepositional	113	19.9
Group	5	
Phrase	108	
Adverbial	2	0.4
Attribute	40	7.0
Other	0	0.0

With the exception of educational register items such as "that question" (clause 596)", "for homework" (clause 675) and "just watch here" (clause 691) and the academic register of "optical illusion" (clause 385), the register selections of Lesson C2 do not vary from mathematical items. While there

is no doubt that the discourse centres around teaching and learning mathematics, the question remains as to the nature of those construction.

Table 8.39 Other register items

	Total
REGISTER ITEMS	15
Educational • technical • jargon • non-technical	13 13
Officialese	
X-ese	1
Academic	1
Youth Culture	
Other	

A non-exhaustive taxonomy of processes and participants is given in Table 8.40 below.

Table 8.40 Taxonomic relations of major participants and processes

Field	Oral linguistic text	Symbolic Text (with language text)	Visual Text (* indicates representation in the visual display)
Co-ordinate Geometry 1. Co-ordinate Plane (meronymy) i. Axes ii. Points iii. Unit circle (co-meronymy)	• some axes, a normal set of axes, x, y, x axis, y axis (co-meronymy, synonymy, repetition) • one, negative one, the x, the y, the distance, point, the y cor-ordinate, zero point six five (co-meronymy, synonymy, repetition) • circle with its centre at the origin of the axes, unit circle, the circle, the radius, (synonymy, repetition)	• x, y (in Table)	*

2. Geometrical Figures			
a. Circle			*
b. Triangle Parts of Figure i. Sides i. Vertices iii. Angles (co-meronymy)	• the triangle • obtuse angled triangle (subclass of triangle) i. • a, c, the side x, the side y (co-meronymy, repetition) ii. • angle A, angle C, the X angle, the angle Y (co-meronymy, repetition)	• x, y • X, Y	*
c. Angle i. Classification of angles ii. Angle relationships	• obtuse angle, right angles, acute angle, of any angle between zero and ninety (co-hyponymy) • ten degrees, twenty degrees (co-meronymy • perpendicular (subclass of class) • supplementary (subclass of class)	• 110^0 70^0 130^0 50^0 150^0 30^0 170^0 10^0	*
d. Lines	• perpendicular line (subclass of class)		*
3. Real number system	• positive, negative (co-hyponymy)		*
3. Trigonometric Ratios (the relations between the sides and angles of a right triangle) i. Sine ii. Cosine	• sin, sine, cosine (co-hyponymy) • y over one	• sin, cos (Table) • $\sin 10^0 = \frac{y}{1}$ • $\cos 10^0 = \frac{x}{1}$	
4. Solution of Triangles. i. Sine Rule (subclass of class)	• sine rule • a over sine A, b over sine B • letters (meronymy)	• SINE RULE $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	
4. Arithmetic Operations (subclass of class: Operative Processes)	• take away, add (co-hyponymy) • over	• $\frac{x}{\sin X}$	
5. Expression of relation	• equation • solution	• $\frac{x}{\sin X} = \frac{y}{\sin Y}$ • $X = 64^0$ or 116^0	

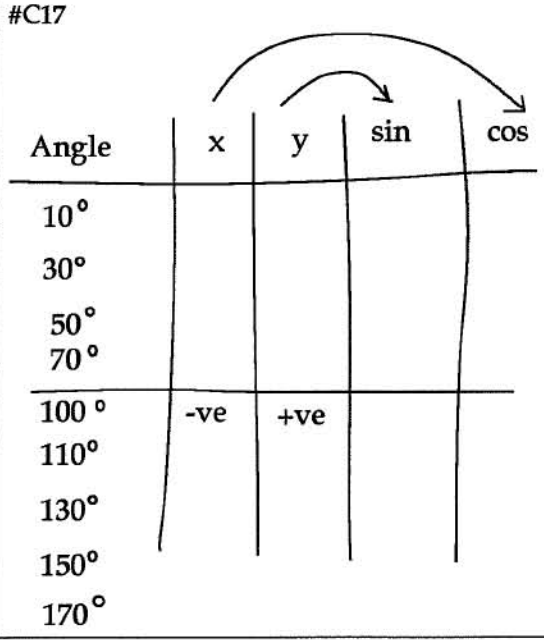
Because of the attempts to link the right triangle definition of the sine and cosine to the co-ordinate plane in order to find the two solutions between zero and one hundred degrees which give particular sine and cosine values and the inclusion of the solution of triangles by use of the Sine Rule, the field of the discourse stretches across many taxonomic relations of classification and composition. Although not included in Table 8.40, the field is extended further when the two triangles which result from the algebraic solution in the final stages of the lesson are constructed. Given the extensive range of the taxonomic fields in combination with non-technical lexical selections and extensive use of pronouns, difficulties in interpretation are understandable.

The nuclear configurations involving the actions that the teacher and students perform in relation to the mathematical participants are commonly realised as physical actions as opposed to Operative processes. For example, "what do we do with the fraction, turn them upside down" (clauses 703 and 704). Once again, the non-technical lexis and patterns of reference do not accord with mathematical discourse.

In combination with these types of actions, configurations also frequently involve mathematical participants and their Attributes as illustrated in the excerpt below in Table 8.41. These nuclear relations are simple given the lack of nuclear rankshifted configurations. We may also note that repetition is a feature of the discourse.

Because of the use of the graphs and diagrams at each stage of the lesson, experiential meaning of the oral discourse largely relates to physiological perceptions in addition to physical actions. It is impossible to ascertain from this lesson alone, however, the degree of success these students experience in the shift to mathematical discourse whereby concepts are constructed semiotically through mathematical symbolism. As seen in the analysis of the discourse of Lesson A, different lexicogrammatical strategies are employed to encode experiential meaning when the constituent code alternates between language and mathematical symbolism.

Table 8.41 Nuclear relations

Clause		Centre	Nucleus	Margin	Periphery
		PROCESS = Range: process	+ Medium +Range: entity	+Agent +Beneficiary	x Circum-stance
469 T	// OK let's go through [[what you 've just discovered]]	• go through	• let's • [[what you 've just discovered]]		
470 T	// firstly when we did one hundred degrees	• did	• we • one hundred degrees		
471 T	// what happened to the 'x' value	• happen-ed d to	• what • the 'x' value		
472 S2	// it became a negative	• became	• it • negative		
473 T	// it became negative	• became	• it • negative		
474 T	// because of course we are reading [down to the 'x' axis]	• are reading	• we • [down to the 'x' axis]		
475 T	// and it 's the other side [of the zero]	• 's	• it • the other side [of the zero]		
476 T	// what happened to the 'y'	• happen-ed to	• what • the 'y'		
477 S3	// stayed positive	• stayed	• (it) • positive		
478 S1	// it stayed positive	• stayed	• it • positive		
479 T	// it stayed positive	• stayed	• it • positive		
	#C17 				

480 T	// and of course when you found the sine and the cosine	• found	• you • the sine and the cosine		
481 T	// they still matched didn't they	• still matched	• they • matched		
482 T	// the 'x' matched [with the cosine]	• matched	• with the cosine	• the 'x'	
483 T	// and the 'y' matched [with the sine]	• matched	• with the sine	• the 'y'	
484 T	// OK let's be a bit more specific then	• be	• let's • a bit more specific		
485 T	// what happened [at one hundred and ten]	• happened	• what • [at one hundred and ten]		
486 T	// [for 'x'] you should still get a negative answer	• should still get	• you • a negative answer		
487 T	// and [for 'y'] you should get a positive answer	• should still get	• you • a positive answer	• for 'y'	
488 T	// what else did you notice	• notice	• you • what else		
489 Ss	// it 's the same <indistinct>	• 's	• it • the same		
490 T	// it was the same	• was	• it • the same		
491 T	// so you found	• found	• you		
492 T	// that a hundred and ten the values were the same [as the values [[you got [for seventy]]]]	• were	• the values • the same [as the values [[you got [for seventy]]]]	• a hundred and ten	
493 S3	// except they were negative	• were	• they • negative		
494 T	// the only difference was [[that the 'x' number was negative [instead of positive]]]	• was	• [[that the 'x' number was negative [instead of positive]]]	• the only difference	
495 T	// the 'y' numbers were identical	• were	• the 'y' numbers • identical		

8.252 Field

While the field of the discourse centres around the mathematical content of the lesson as demonstrated by the range of microgenres, the taxonomic relations reveal a wide range of mathematical concepts. That is, the definitions of the sine and cosine in a right triangle are linked to the co-ordinate plane representations. Through this strategy, the two solutions for any given sine value are found. Not only is this related to the solution of

triangles using the Sine Rule, but so too is the construction of the two triangles which result from this solution. The nature of the lexical selections and the use of pronouns however, operate to make these taxonomic relations difficult to reconstruct.

This lesson highlights the need for successive lessons to be analysed. It is not apparent whether the students can shift from discourse of concrete activities to the construction of mathematical knowledge as realised in the genres of mathematics. As suggested by this analysis, a practical approach has dramatic consequences for the texture of the oral discourse. With respect to experiential meaning, nuclear configurations are simple, rankshifted clauses are minimal and Operative processes are not featured in the pedagogical discourse.

8.253 The Mathematical Text

The visual display is central to the construction of the experiential meaning in Lesson C2. Before investigating the contributions of each code, we may note that the teacher employs non-generic visual aids for experiential meaning. In Figure 8.8, the arrows serve to link the values for "x" with "cos" and the values for "y" with "sin".

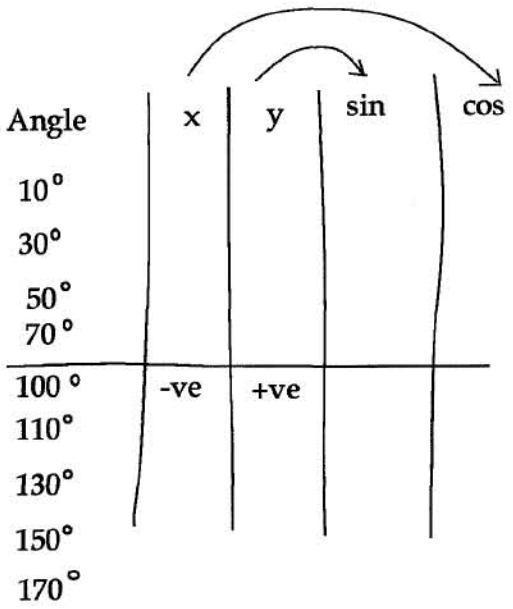


Figure 8.8 Visual aids for experiential meaning

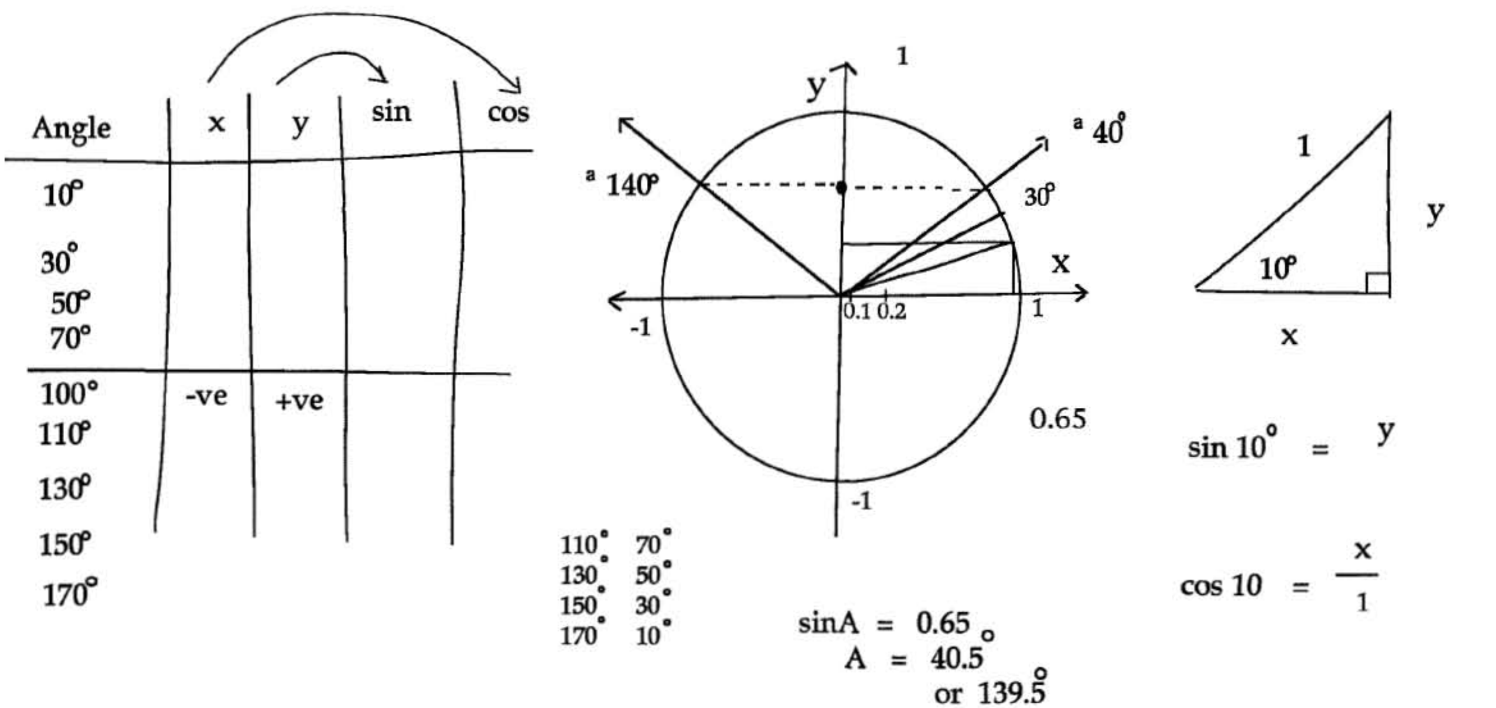


Figure 8.9 The board text and experiential meaning

For convenience, the board text is reproduced in Figure 8.9. The table, graph, diagram and symbolic text make unique contributions in terms of experiential meaning of the board text. At the centre of the display is the graph. Here the interplay of Episodes concerning the intersection of the different angles with the unit circle is captured. However, these points of intersection are not marked by a filled dot nor is the rotational size of the angle marked by a curved arrow at the origin. A sense of dynamic play, however, is realised through the diagonal slope of the angles which is offset by the stability of the axes and the unit circle. Given the freehand style of representation, the horizontal and vertical lines and the circle lack the degree of stability of their generic counterparts.

The teacher explicitly commands the students to draw in the horizontal and vertical lines from the point of intersections of the angle and the unit circle as given in the following excerpts.

150	T	// OK where the line [[that you 've just drawn]] intersects the circle
151	T	// where it meets the circle
152	T	// drop a perpendicular line [down to the 'x' axis]
153	T	// a perpendicular line [down to the 'x' axis]
157	T	// read [from your axes] [[the number that corresponds to [[where that perpendicular line meets the axis]]]]

When the reverse procedure occurs and the students are asked to find the size of the angles with a sine value of 0.65, this value is marked by a filled in dot with the horizontal dashed lines representing the process of reading across to the unit circle to find the appropriate angle.

Despite the explicit commands to "drop a perpendicular line" (clause 152), the horizontal and vertical lines marking the x and y co-ordinate values could nevertheless be interpreted as a case of semiotic metaphor. That is, the physical process of reading the 'x' and 'y' co-ordinates on the visual display is marked by new participants in the graph in the form of the horizontal and vertical line segments. Together with the ray realising the angle, the introduction of these participants is crucial because it means that the diagram may be constructed as a separate entity. That is, the display of the diagram with the ten degree angle is lifted directly from the graphical display. By isolating and combining the participants to form this right

triangle, the experiential link is made between the co-ordinate display and the right triangle definition of the sine and cosine.

The experiential meaning potential of the graph, however, is such that the size of the angles is not limited as with the triangle. The rotational size of any angle may be depicted. In this way, the sine and cosine of any angle may be investigated with the result that multiple solutions are possible for any sine or cosine value. More specifically, the triangle is used to describe the relationship between the angles and sides of a right triangle through definition of the trigonometric ratios while the graph is used as an aid for solving trigonometric equations. The unit circle is precisely chosen because the sine and cosine values correspond to the y and x co-ordinates respectfully.

The meaning potential of the graph and diagram means that new entities in the form of right triangles are created. From this whole, the relations between the parts, or the size of the angles and the lengths of the sides, are encoded in mathematical symbolic form. That is, the meaning potential of the mathematical symbolism is such that the relationships existing between the parts of the whole may be captured. Significantly, the graph depicted in Lesson C2 is limited in that only snap shots of differing angle sizes are taken. The patterns of continuous variation may be displayed through construction of another graph in which the x and y axes are the angle size and the sine or cosine values respectively. The symbolic description of such curves are "y = sinx" and "y = cosx".

The oral discourse realises commands to perform actions which result in a visual display. The function of the table is to record the results for each angle. In this way the patterns may be used to formulate the general results. From the patterns which emerge from the visual display, the relations of the parts to the whole are described through mathematical symbolism.

I would like to note that generic board notes are not constructed in Lesson C2. The only lesson to deviate from this pattern is Lesson A where comprehensive board notes accompanied the solution to the problem. In addition to making the board text of Lesson C2 difficult to revisit, the students are not being inducted into written mathematical discourse. In addition, abbreviated hybrid notation is realised in the board text. In Lesson

C2, the "+ve" and "-ve" realise non-generic selections from mathematical symbolism and language. As may be recalled, a more extreme version of this phenomenon also occurred in the visual texts in Lesson C1.

The nuclear relations for the board text involving the solution of the triangle using the sine rule is given below in Table 8.42. As may be seen, the maximal rank of embedding of two occurs in the first three lines with the process of division realised through spatial position. This display serves to highlight the lexicogrammatical strategy of rankshift which occurs in even the simplest of symbolic expressions.

Table 8.42 Nuclear relations in the symbolic text

	Clause	Cent-re	Nucleus
		PROC-ESS = Range: proc-ess	+ Medium + Range: entity
1.	$[[\ \frac{x}{\sin X}\ ]] = [[\ \frac{y}{\sin Y}\ ]]$		
	Rank 1	• =	• $\frac{x}{\sin X}$ • $\frac{y}{\sin Y}$
	Rank 2 (i)	• ÷	• x • sinX
	Rank 2 (ii)	• ÷	• y • sinY
2.	$[[\ \frac{7}{\sin X}\ ]] = [[\ \frac{5.5}{\sin 45}\ ]]$		
	Rank 1	• =	• $\frac{7}{\sin X}$ • $\frac{5.5}{\sin 45}$
	Rank 2 (i)	• ÷	• 7 • sin X
	Rank 2 (ii)	• ÷	• 5.5 • sin 45
3.	$[[\ \frac{\sin X}{7}\ ]] = [[\ \frac{\sin 45}{5.5}\ ]]$		
	Rank 1	• =	• $\frac{7}{\sin X}$ • $\frac{5.5}{\sin 45}$

	Rank 2 (i)	• ÷	• 7 • sin X
	Rank 2 (ii)	• ÷	• 5.5 • sin 45
4.	**sin X = 0.8999 ...**	• =	• sinX • 0.8999
5.	**X = 64 ^{0} or 116 ^{0}**	• =	• X • 64 ^{0} or 116 ^{0}

8.26 Logical Meaning

8.261 General Lexicogrammatical Patterns, CONJUNCTION & CONTINUITY and Logical Metaphor

The incidence of selections from the systems of EXPANSION and PROJECTION are summarised below in Table 8.43.

Table 8.43 Logico-semantic relations

NATURE OF RELATION	Total	Percentage (1 d.p.)
	662	100
Expansion	219	33.1
Projection	64	9.7
No relation	379	57.2

While comparable with Lessons B and C1, the occurrence of relations involving EXPANSION is significantly lower than Lesson A. As will be seen, however, in Lesson C2 over fifty percent of these relations are implicitly realised. On the other hand, the incidence of selections realising PROJECTION is comparable with Lesson A and Lesson B and greater than Lesson C1. With respect to the realisation of logical meaning, it appears that the descending order of occurrence is Lesson A, Lesson B, Lesson C2 and Lesson C1.

As displayed in Table 8.44 below, student clauses realise minimal logical relations. As for Lesson B and Lesson C1, students do not engage in constructing logical connections. Instead their contributions are marked as chorus responses which are characterised by brevity and ellipsis.

Table 8.44 Logico-semantic relations: Teacher and student contributions

NATURE OF RELATION	Total	Percentage (1 d.p.)
Expansion (n =219)		
Teacher	207	94.5
Students	12	5.5
Projection (n = 64)		
Teacher	64	100
Students	0	0.0

The relations of PROJECTION mainly involve those realising Idea although Locution features more prominently in Lesson C2 than in other lessons.

Table 8.45 Interdependency and PROJECTION

PROJECTION	n = 64	
	Paratactic	Hypotactic
	0% (0)	100% (64)
Idea	0% (0)	68.8% (44)
Locution	0% (0)	31.2% (20)

The logical relations involving EXPANSION are displayed in Table 8.46 below. As for each lesson, selections individually involving parataxis and Enhancement form the dominant categories. However, the oral discourse of Lesson C2 departs from other lessons in that the dominant form of logical relations are paratactic relations involving Extension. Once again, this indicates that the nature of the discourse of Lesson C2 differs from that typically realised in mathematics lessons as evidenced in this study. Although Consequential relations of 'consequence' and 'condition' still feature, the field structured nature of Lesson C2 means that Additive relations predominate. In addition, internal relations realising the rhetorical organisation of arguments are minimal.

Table 8.46 Interdependency and EXPANSION

EXPANSION	n = 219											
	Cohesive 6.8% (15)				Paratactic 63.9% (140)				Hypotactic 29.2% (64)			
Elaboration 11.9% (26)	2.3% (5)				9.1% (20)				0.5% (1)			
Extension 37.4% (82)	2.7% (6)				32.9% (72)				1.8% (4)			
Enhancement 50.7% (111)	1.8% (4)				21.9% (48)				26.9% (59)			
External (186) Internal (33)	Internal 9		External 6		Internal 23		External 117		Internal 1		External 63	
Explicit (145) Implicit (74)	Ex 0	Im 9	Ex 3	Im 3	Ex 2	Im 21	Ex 91	Im 26	Ex 1	Im 0	Ex 48	Im 15
Elucidative (26)												
opposition (21)		4				17						
clarification (5)		1				3			1			
Addition (54)												
addition (49)			1		2		36	8			2	
alternation (5)							4	1				
Comparative (27)												
similarity (2)			1				1					
contrast (25)		1		3		1	15	3			2	
Temporal (36)												
simultaneous (18)							1				13	4
successive (18)							8	5			4	1
Consequential (76)												
purpose (5)							1					4
condition (17)		1					1				14	1
consequence (47)			1				23	9			12	2
concession (3)		2					1					
manner (4)											1	3

We may note that over fifty percent of the logical relations of expansion are implicitly realised as displayed in Table 8.46. In combination with the logical meaning of the board text as discussed in section 8.263, it becomes apparent that from the perspective of the students, the logical connections realised in Lesson C2 may be difficult to follow.

The few relations of EXPANSION realised in the student clauses are displayed in Table 8.47. As may be seen, the majority of these relations involve paratactic relations of Extension which once again departs from patterns of logical relations of mathematical discourse.

Table 8.47 Interdependency and EXPANSION: Student contributions

EXPANSION	n = 12		
	Cohesive 8.3% (1)	Paratactic 66.7% (8)	Hypotactic 25.0% (3)
Elaboration 16.7% (2)	8.3% (1)	8.3% (1)	0% (0)
Extension 50.0% (6)	0% (0)	41.7% (5)	8.3% (1)
Enhancement 33.3% (4)	0% (0)	16.7% (2)	16.7% (2)

The incidence of the selections from the system of CONTINUITY is significantly lower than Lesson A. However, an average of 10.8% clauses in Lesson C2 contain a Continuative which means that these selections are made more often than in Lesson B and C1. It appears that the regular patterns of movements between the microgenres of Lesson C2 cohere in a progressive fashion.

The trend of realising logical meaning congruently found in the other lessons extends to Lesson C2. As displayed in Table 8.48 below, the one exception concerns the shift from the Conjunction "so" to the process "means". This example of the metaphorical realisation of logical relations is

found in each lesson indicating that it is a feature of mathematical pedagogical discourse.

Table 8.48 Grammatical metaphor and logical relations

RANK AND METAFUNCTION	GRAMMATICAL METAPHOR
Clause complex: **LOGICAL**	
relator —>	**process**
so	336 T // [over one] just **means** 'x'
	753 T // **it means** [[that we can draw that triangle]]

8.262 Mathematical Reasoning

Lesson C2 is a practical lesson whereby the students draw angles between zero and one hundred and eighty degrees on graph paper and record the results for the values of the x and y coordinates, the sine and cosine values for angle. The theory is developed by the teacher on the board. However, the practical orientation of this lesson means that the typical Consequential relations of Enhancement are overshadowed by the selections of Additive relations. In addition, given the relatively low incidence of logical relations in Lesson C2 and the high degree of implicit realisation, long implication chains of reasoning are not a feature of the discourse. That is, the generic forms of mathematical reasoning are not realised in Lesson C2. Further to this, the mathematical definitions and results on which the logical connections are made are not explicitly stated. As seen in the following section, the reliance on the visual depiction has significant implications for the realisation of logical meaning.

8.263 The Mathematical Text

The conjunctive reticula for the logical relations in the board text of Lesson C2 are displayed in Figure 8.10. This representation highlights several features of the logical meaning of the board text. Firstly, the logical relations straddle the visual displays of the graph, diagram and table and the symbolic

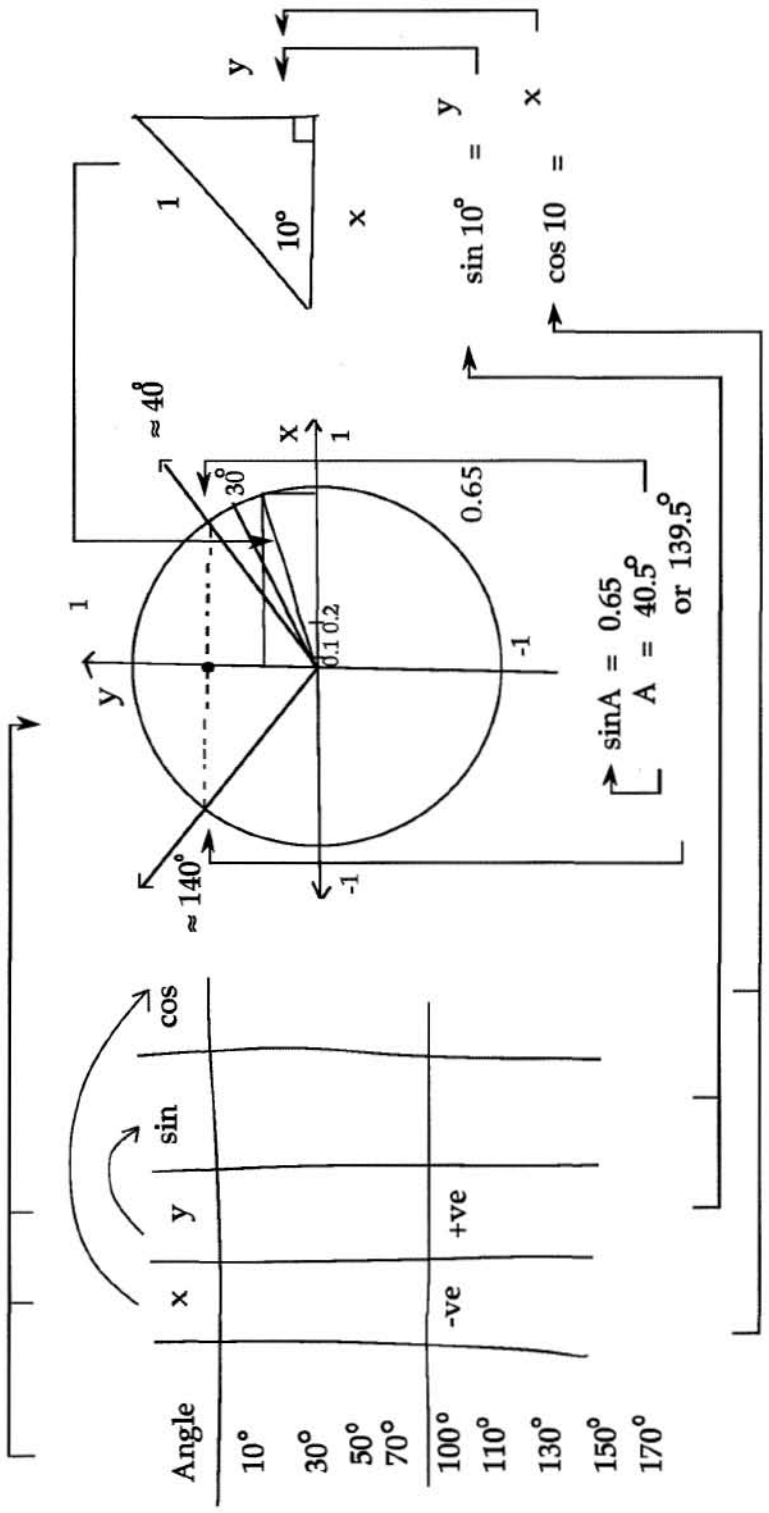


Figure 8.10 Logical relations in the board text

text. As may be seen, the graphical display is the forum for making the logical connections necessary for the solution of a trigonometric equation. However, one difficulty is that strategies for realising logical meaning across visual codes are implicit and as a consequence largely depend on the surrounding verbal discourse. Given the lack of explanatory written notes, this means that when the text is viewed in isolation, the logical meaning must be inferred from the experiential and textual discursive links between codes.

Secondly, in the case of the graph, diagram and table, logical meaning must be inferred from the systems which realise experiential meaning. That is, logical meaning is implicitly realised in visual representation. Logical meaning is inferred from circumstance, the participant form, the relations between participants, the interplay of Episodes and patterns of covariation in the graph. With respect to the latter, in this particular graphical display there are only snap shots of the patterns of variation between the size of the angle and the sine and cosine values of this angle. The logical conclusion as to the size of the angle for any sine or cosine value is dependent upon the position of the ray which forms the angle and the scales inherent in the co-ordinate plane. Within the tabular representation, the arrows linking 'x' with 'cos' and 'y' with 'sin' function to realise experiential meaning as opposed to the logical meaning. With respect to the diagram and the symbolic text, the logical relations based on mathematical definitions of sine and cosine in the right triangle remain implicit both in the oral and visual discourse. This pattern is repeated in the solution of the homework problem involving the sine rule.

Significantly, although logical meaning is intuitively accessible in visual display, there are no systems which explicitly realise this meaning. In other words, unlike mathematical symbolism and language, paradigmatic choices for realising categories of logical meaning do not exist. Logical meaning must be inferred from the experiential content of the visual display and realised through language or mathematical symbolism. Therein lies the difficulty of grasping the content in Lesson C2. Firstly, the logical connections span visual semiotic modalities. Secondly, logical meaning is not explicitly realised in visual depiction. Although intuitively accessible, logical meaning must be extrapolated from the selections made in the systems realising experiential meaning. In this case, this includes the

selections from the systems constituting the grammar of geometric representations in the coordinate plane.

Logical meaning of the visual display is constructed in Lesson C2 through the support of the oral discourse and contextual features such as gesture. However, given the lack of explicit realisation of logical connections through mathematical symbolism or language and the non-generic forms of board representation, the logical relations would most likely be difficult to reconstruct. There are no accompanying board texts which make explicit the chains of reasoning which give rise to the new mathematical results.

8.3 The Texture and Ideology of Lesson C2

The method of development of Lesson C2 is based on the 'Stack' whereby the macro-Theme is finding the obtuse angle which satisfies the equation obtained from the use of the Sine Rule.

64 T // we 're going to have another look
65 T // or a look at another way [[to find out that]]
66 T // and then you can check the answer[[you 've got]] [with the method [[we 'll use]]]
67 T // to see
68 T // if it was correct

After the macro-Theme is introduced, the method of development of Lesson C2 is a clear example of the 'Step'. The Practical Activity and the Practical Activity Discussion which dominate Lesson C2 proceed as a series of instructions which are completed and discussed. This pattern is repeated in the Homework Discussion where the solution is presented as a series of steps. There is little sense of the Balance or Chain whereby other avenues are explored or poise or counter poise plays a decisive role.

The thematic strategies involve establishing 'facts' from the patterns resulting from the practical activity and calls to established procedures and mathematical results. The former is illustrated in the following excerpt.

672 T // but [[what you do have to do]] is [[consider the fact [[that <<yes>> there is more than one angle [[that will give you a sine value [of zero point six five]]]]]]]

The texture of Lesson C2 is loose especially when compared to the texture of Lesson A. The weave resulting from the splitting and cojoining of chains

lacks density and the absence of multiple levels of rankshift means that the fibres are somewhat fine. Peaks of interpersonal meaning realised through paralinguistic behaviour and colourful lexical selections mean that the terrain is not flat but rather is landscaped to include memorable landmarks. The interwoven patterns resulting from the use of multisemiotic resources do not seem to create such startling patterns as found in Lesson A. This is due to the reliance on visual cues, the centrality of visual depiction and the nature of the linguistic selections for mathematical participants. With the minimal use of mathematical symbolism, the depths of meaning encoded in the discourse of Lesson A are not replicated in the discourse of Lesson C2.

While nevertheless remaining a significant feature of Lesson C2, the foregrounding of interpersonal meaning is not as pronounced as in Lesson B and Lesson C1. The microgenres constituting Lesson C2 realise a rhythmic pattern which is seldom interrupted by interpolated activities involving extremes of interpersonal meaning. This means that the field of the dominant microgenres centres on the mathematical content of the lesson.

While Lesson A and Lesson C2 share the common characteristic of lacking a monofunctional tendency orientated towards interpersonal meaning, the tenor relations realised in each lesson differ dramatically. Patterns of dominance are found in each dimension of interpersonal meaning in Lesson A. The order of equality is the highest order possible. On the other hand, although the dominating position of the teacher is evident through the speech role of primary knower and secondary actor and the commands which realise interpersonal congruence as opposed to metaphor, the remainder of the lexicogrammatical and discourse choices realise patterns of deference in Lesson C2. The order of equality is low. This position of deference is realised through tagged declaratives, paralinguistic behaviour, ellipsis, relatively lower levels of modality, colloquial selections and minimal emphasis on the individual as realised by the absence of Vocatives and multiple instances of chorus responses. Affect is realised through exclamatives, intensification and attitudinal lexis and contact is involved as evidenced by colloquial selections. The patterns differ from Lesson C1 in terms of a lower social distance between the teacher and the students and a lower dependence on covert strategies for maintaining class control.

The interpersonal patterns of deference in Lesson C2 do not accord with the dominating relations realised in mathematical discourse. Further to this, the lexicogrammatical and discourse selections realising experiential, logical and textual meaning in the oral and visual discourse are marginal to the genres of mathematics. While stretching across many taxonomies, the mathematical register items are often non-technical and pronoun selections. The simplicity of the reference patterns and nuclear configurations realised in the oral discourse do not reflect patterns found in mathematical discourse. Logical connections are left implicit as the board texts consisting largely of visual depiction are not accompanied by explanatory notes.

The texture of Lesson C2 highlights the restricted functionality of practical lessons in mathematics. While useful for introducing mathematical results which are intuitively accessible through concrete manipulations and visual display, the texture of the oral discourse differs dramatically from pedagogical discourse involving the construction of mathematical meaning as semiotically construed through mathematical symbolism. That is, the texture of the discourse of Lesson C2 is similar to that found in the construction of everyday meaning. There is no evidence to suggest that a shift to mathematical discourse has been made.

While Lesson C2 centres on the mathematical content and a lack of tension in the tenor relations, the lexicogrammatical and discourse selections nevertheless reflect the marginal position realised in Lesson C1. In addition minimal resistance is found in response to the step-like structure of Lesson C2. Students willingly follow simple instructions as if acquiescence is an accomplished fact. Yet despite the levels of success of Lesson C2 as realised by the teacher comment "you like this, you can do it" (clauses 241 and 242), the students remain firmly marginalised with respect to the discourse of mathematics. Judging by the 1995 TEE results, it appears that this position does not change.

CHAPTER 9

Behind the Fiction

9.1 The Final Grade in Secondary Education

The disparate nature of the oral pedagogical discourse and board texts in classrooms differentiated on the basis of school type, gender and social class is demonstrated in Chapters 5 to 8. The differing levels of participation in the discourse of mathematics are reflected in the scores for the mathematics subjects in the 1995 Tertiary Entrance Examinations (TEE). As I demonstrate below, these differences extend to the Tertiary Entrance Scores (TES) which determine access to tertiary study.

The TES for students in Schools A, B and C are displayed in Graph 9.1 below. We may note that the patterns found in the TEE mathematics scores are replicated as the state mean TES is 283.2 and the mean scores for Schools A, B and C are 314.3, 293.8 and 253.6 respectively. The minimum TES for the first round offers for 1996 at the University of Western Australia (UWA) are displayed in Table 9.1.

Table 9.1 Minimum TES for admission at the University of Western Australia (UWA)

COURSE	Minimum TES
Agriculture	307
Arts	307
Asian Studies	307
Commerce	307
Computer and Mathematical Sciences	307
Economics	307
Horticulture	307
Natural Resource Management	307
Physical and Health Management	307
Science	307
Wool Science	307
Fine Arts	311
Architecture/Environmental design	331
Engineering	331
Landscape Architecture	331
Asian Studies/Engineering	352
Commerce/Engineering	359
Science/Engineering	384
Law	404
Medicine	436

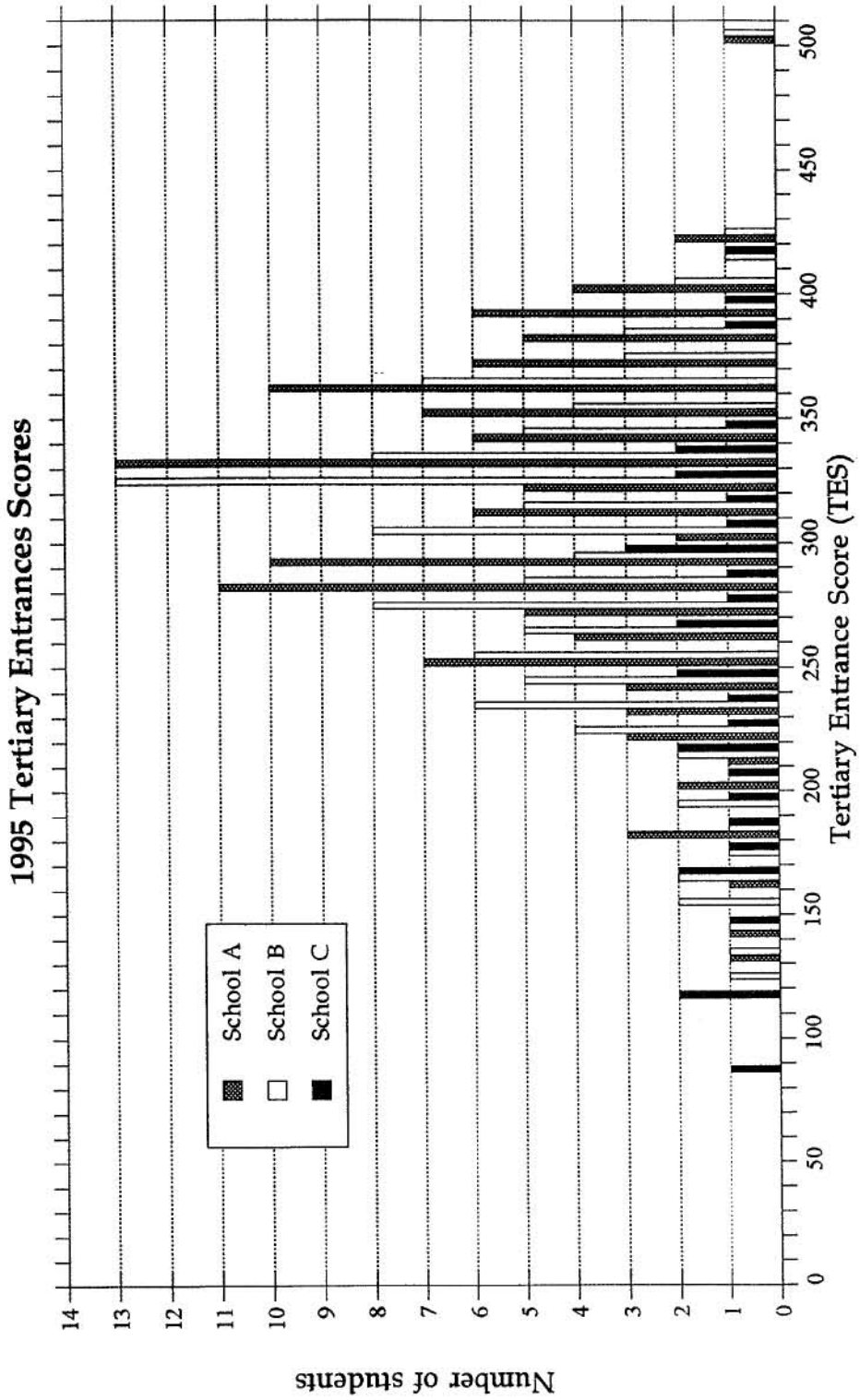


Figure 9.1 Tertiary Entrance Scores for Schools A, B and C

If the 1995 TES for students in Schools A, B and C are compared with entrance requirements at UWA, the numbers of students from each school qualifying for entrance into the university and enrolment in Engineering/Science, Law and Medicine are displayed in Table 9.2.

Table 9.2 Students from Schools A, B and C qualifying for entrance at the University of Western Australia (UWA)

Courses	School A	School B	School C
Entrance to UWA	73	54	9
Engineering/Science	15	8	3
Law	7	4	1
Medicine	1	1	0

These figures highlight the differential access of students from Schools A, B and C to the discourses of higher education and the subsequent rewards that certification by these institutions offer. These rewards include not only social status and material gain, but also certification of the 'right to speak'. The entire population is thus ensnared in a web of codification and stratification by the credentialising institutions which operate to rank individuals according to indicators of usefulness in maintaining the interests of capitalist society. And in these few figures we may see the patterns of dominance that exist in our society.

In my final remarks I relate Bernstein's theory of pedagogical practice and coding orientations and Halliday's formulations of written and spoken language to the results of my analyses of the discourses of the mathematics classrooms. Interpreting these in terms of Foucault's formulations of the operation of power in the construction of knowledge, truth and the subject, I attempt to give reasons for the differing discourses of each mathematics lesson.

9.2 The Private and Government School Sectors

As I discuss in Chapter 1, Kenway's (1987; 1990) analysis reveals how the interests and privileges of the private school sector were protected and even

extended in the 1980s through the discursive practices of the print media. In the 1990s, it is 'understood' that private elite educational institutions provide the best education. Front page headlines such as "All-girl schools top WA TEE list" (*The West Australian,* January 3, 1996) which accompanied the release of the 1995 results for the Tertiary Entrance Examinations (TEE) in Western Australia function to naturalise this position. It has become our commonsense, firstly, that these institutions have the right to exist and, secondly, that the privileges offered to their select clientele should be supported through government funds. There is no debate as to the status of education as a market commodity that may be purchased by those that have sufficient resources to do so.

The Australian Commonwealth and State governments both contribute funds to private schools. The amount of the Commonwealth money allocated per student depends on the category which is assigned to each school according to its material resources. The categories of Commonwealth assistance to Schools A and B are "Level of Assistance - Level 2" (Commonwealth Government, 1994, p. 8). Apart from the Japanese School in Perth which is categorised as Level 1 (Commonwealth, 1994, p. 8), the two private schools in this study represent the best resourced and wealthiest schools in Western Australia. Maher (1995) from The Association of Independent Schools of Queensland Inc. lists the Commonwealth Government funding for these schools as $938 per student per annum for the period 1994-1996.

State funding is based on divisions created from combined Commonwealth categories. In this case, categories 1, 2 and 3 combine to form the first division. That is, the private secondary schools in this study are located in the first bracket with the state funding of $918 per student per annum. However, the State government funding does not stop there. Albert (1994) explains that under Richard Court's State Liberal Government, funding to private schools rose substantially in 1994 as the result of other major contributions. In a letter to Mr Bill Hann, Executive Director of the Association of Independent Schools of Western Australia, Albert from the Western Australian Office of Non-government Education comments: "It may interest you to note that overall, funding to non-government schools has increased by 12.1% over 1994" (Albert, 1994, p. 1).

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The West Australian reports that the trend of increased funding to the private school sector has been a feature of state government spending over the last three years in Western Australia. "Government spending on private schools has risen 40 per cent in real terms in three financial years but spending on State schools has languished, according to the State Opposition" (*The West Australian*, January 5, 1996, p. 4). In this article titled "PRIVATE SCHOOLS GET THE CREAM: ALP" it is reported that "Public education spending had remained level with inflation, a situation which gave no real increase to a system that had to cater for more and more students".

Although *The West Australian* reports the discrepant support for the different school sectors, the heading and the location of the article on the bottom right hand side of page 4 belie the import of the message. The article illustrates that an educational hegemony is thriving as part of our commonsense. Indeed comments such as "it appears that the role of public schools may be changing" (Department of Employment Education and Training, 1993, pp. 203) which appears in discussions of the disproportionate contribution of the government school sector in providing university entrants in the 1993 *National Report on Australia's Higher Education Sector* naturalise this position. The interests of the privileged advancing to higher education are protected in the field of secondary education.

The 'success' of the elite private schools in terms of providing entrance to tertiary institutions for its students is discussed in the following three sections. I discuss Bernstein's descriptions of pedagogic practices and the social basis of different coding orientations and issues of gender.

9.3 Mathematics Education

Bernstein (1990) categorises pedagogic models as oppositions between the conservative or traditional and the progressive or child centred. In order to locate these models, Bernstein describes the essential logic of any pedagogic relation as consisting of three rules: hierarchical rules, sequencing rules and criterial rules. Bernstein thus describes two types of pedagogic practice: "If the rules of regulative and discursive order are explicit (hierarchy/sequence/pace criteria), I shall call such a type a visible pedagogic practice (VP) and if the rules of regulative and discursive order are implicit, I

shall call such a type an invisible pedagogic practice (IP)" (Bernstein, 1990, p. 70).

The basic opposition between visible and invisible pedagogies is the emphasis on "transmission-performance" and "acquisition-competence" respectively (Bernstein, 1990, p. 71). That is, visible pedagogies are concerned with the external 'gradable' performance of the learner against model texts while invisible pedagogies are concerned with internal procedures of students such as cognitive, linguistic, affective, motivational features which are common but unique to each learner. In this practice, the emphasis is shared procedures of acquisition and individual competencies. On the other hand, the emphasis of visible pedagogies is directed towards the performance of the child. The text which the child creates is graded in the light of specific criteria.

Bernstein's configuration of visible and invisible pedagogical practice with respect to traditional and progressive pedagogical models is given in Figure 9.2.

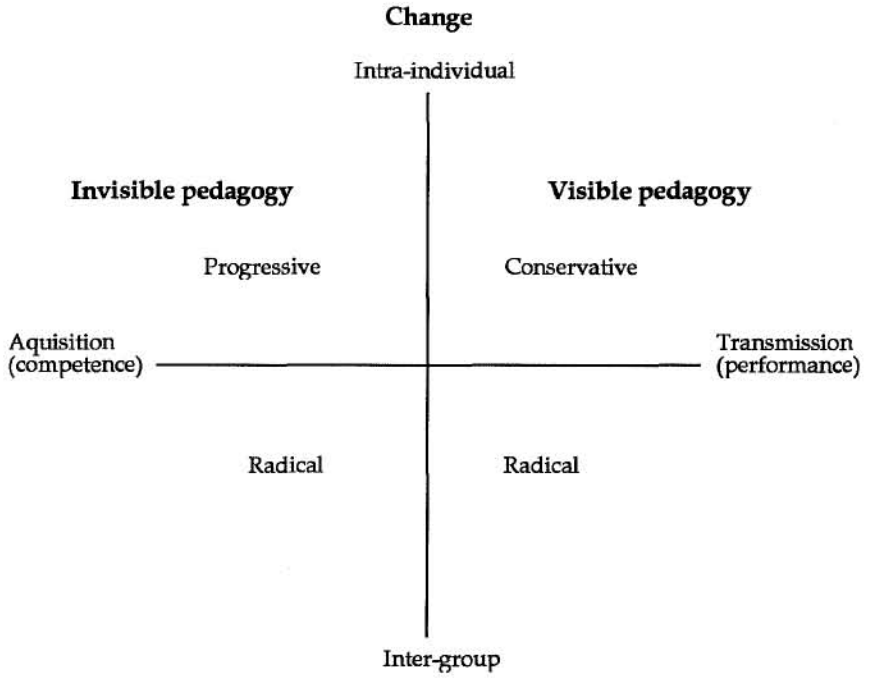

Figure 9.2 Location of pedagogical practices (Bernstein, 1990, p. 72)

Significantly Bernstein locates conservative pedagogical practices as visible pedagogies with change directed towards the individual while radical

pedagogical practices may be visible or invisible pedagogies with change directed towards social groups. Progressive pedagogies are, however, based on invisible pedagogies where the change is individual. Martin (1993a) redefines these positions advocated by Bernstein to include a relabelling of radical practices based on visible pedagogies and orientated towards social group change as 'subversive'. Pedagogical practices based on the social theory of Hallidayan systemic linguistics such as those which were developed in the Sydney Metropolitan East Regional Disadvantaged Schools Program (Martin, 1993a) are located within this group.

Firstly we may note that in so far as the ultimate result of the education system is stratification by rank, it may be classified as a visible pedagogical practice. Secondly, the lessons analysed in this study reflect differing pedagogical practices. This point merits some discussion.

Lesson A realises a visible pedagogy with the individual as the primary focus. The strong classification (recognition rules of acceptable combinations of field, tenor and mode selections) and framing (regulative control) typical of visible pedagogies is evident in the tight structure of Lesson A as evidenced by the movements between and the nature of the microgenres. Lesson A is an example of the traditional model in which the ideology of the educational system as a whole is reflected. The pedagogical practices of this lesson are geared towards meeting the requirements of the educational system. On the other hand, Lesson C1 is an example of an invisible pedagogical practice. The weak classification (multiple combinations of field, tenor and mode selections) and framing (plays with regulative control) are evident in the erratic movements between major and interpolated lesson microgenres and the covert form of manipulation. The emphasis on interpersonal meaning means that the social goal of the lesson is not primarily learning mathematics. In other words, the pedagogical practices of Lesson C1 mean that students are not being prepared to meet the demands of the system. In a similar fashion, Lesson C2 is an example of an invisible pedagogical practice. The weak classification but strong framing of Lesson C2 is the result of the step-like structure of the practical nature of the lesson. The underlying model is perhaps progressive as it is orientated towards individual student 'discovery'. However, the student texts do not accord with generic specifications. As I have shown, the resulting discourse is marginal to the discourse of mathematics. On the other hand, Lesson B

contains features of both visible and invisible pedagogical practice. The female students may be groomed to meet the demands of the system, but not that of society in general. This point is addressed in section 9.5, "Gender and Mathematics".

Following Martin (1993a) and the Sydney school of systemic linguists, I advocate a visible pedagogical practice which aims at making explicit the genres of mathematics and the strategies through which meaning is constructed in mathematical texts. In such a practice, the focus is mathematical discourse rather than the 'developing child'. As Walkerdine's (1984; 1986; 1988; 1989) analyses reveal, in mathematics education the discursive practices of progressive and child centred pedagogies function to create the 'truth' about students through normalising patterns of development and reasoning. The ultimate concern is positioning the individual as opposed to the construction of mathematical generic texts and cultural contextualisation of mathematical knowledge. In these movements, not only is there a mismatch with the pedagogical practices of the education system as a whole, but rather than being a liberating pedagogy, these practices result in a tightening of the strait-jacket of conformity through normality. The focus remains tied to the child in recent theories in mathematics education such as 'constructivism'. Evolving theories such as 'social constructivism' where the focus is directed towards collaborative learning environments, techniques of reflection, the deconstruction of myths and so forth nevertheless suffer from want of a linguistic model with which to proceed. The so-called critical paradigm in mathematics education has hedged about the nature of the reality constructed in mathematical discourses and the functions it serves in the discursive practices of contemporary society.

In summary, I advocate replacing humanist rhetoric with explicit formulations of the rules of the game. As the educational system functions through the grading and ranking of student texts against external models, movements in mathematics education should aim at making explicit the strategies through which meaning is constructed in the genres of mathematics. In this way, the functions of mathematical knowledge in contemporary society may be contextualised together with different subject positionings. Only then may we have a level playing field where the 'right to speak' is no longer in the hands of the minority.

9.4 Social Class and Mathematics

> Class codes and their modalities are specific semiotic grammars that regulate the acquisition, reproduction, and legitimation of fundamental rules of exclusion, inclusion, and appropriation by which and through which subjects are selectively created, positioned, and oppositioned (Bernstein, 1990, p. 47).

Following Bernstein (1971; 1973; 1977; 1990), patterns of differential educational achievement are explained by the match or mismatch between the discursive practices of school and that of the student. Bernstein theorised the social basis for different speech forms and so linked social structure to ranges of meaning potential as the determining factor in educational achievement. He argued that "social relations acted selectively on principles and focuses of communication and these in turn created rules of interpretation, relation and identity for the speakers" (Bernstein, 1990, p. 95). The description of the different forms resulted in his conceptualisation of elaborated and restricted codes which followed his initial formalisation of public and formal language use.

Bernstein (1990) considered his initial list of linguistic indicators of speech forms for restricted codes (Bernstein, 1971, p. 62) and elaborated codes (Bernstein, 1971, p. 282) as inadequate. The list of indicators for restricted codes included:

> (1) Short, grammatically simple, often unfinished sentences, a poor syntactical construction with verbal form stressing the active mood.
> (2) Simple and repetitive use of conjunctions (so, then, and, because).
> (3) Frequent use of short commands and questions.
> (4) Rigid and limited use of adjectives and adverbs.
> (5) Infrequent use of impersonal pronouns as subjects (one, it).
> (6) Statements formulated as implicit questions which set up a sympathetic circularity...
> (7) A statement of fact is often used as both a reason and a conclusion, or more accurately, the reason and conclusion are confounded to produce a categoric statement...
> (8) Idiomatic selection from a group of idiomatic phrases will frequently be found.
> (9) Symbolism is of a low order of generality
> (10) The individual qualification is implicit in the sentence structure, therefore it is a language of implicit meaning. It is believed that this fact determines the form of the language.
>
> (Bernstein, 1971, p. 62)

The problems associated with these indicators arise from Bernstein's background in sociology rather than linguistics. In addition, the lists should

be understood in terms of the context of the time. Bernstein's theories were ground-breaking formulations that suffered from the absence of a fully developed linguistic model. With the subsequent formulation of Hallidayan systemic linguistics, Bernstein's thwarted project of defining the semantics of restricted and elaborated codes through linguistic descriptions is now possible. Indeed some of the indicators in the above list bear resemblance to those identified in this study. For example, as summarised in (1) above, student responses in Lessons C1 and C2 are brief and ellipsis is common. Teacher commands fit the description given in (3) and fixed phrases as suggested by (8) are found proportionally more often in the lessons of working class students. Bernstein (1990), however, maintains that the above characteristics were generated by semantic rather than linguistic concerns where the defining feature of a restricted code is its orientations towards implicit meaning. This view accords with the covert orientation of the discourse of Lesson C1. Regardless of the problems with his formulations, however, Bernstein's later descriptions of restricted and elaborated codes offer insights into the marginalisation of working class students with respect to the discourses of mathematics.

Bernstein's semantic basis for distinguishing restricted and elaborate codes is respectively particularistic/local/context-dependent meanings versus universalistic/less local/more context-independent meanings. As he comments:

> Clearly, in a fundamental sense, all meanings are context-dependent, but meanings can differ with respect to their relationships to a local context and in the nature of the social assumptions upon which they rest (Bernstein, 1990, p. 96).

Bernstein thus proposed that a code was restricted or elaborated to the extent that the meanings were immediately context-dependent or context-independent. In addition Bernstein outlined the social relationships which generated these different codes through classification of family types according to the basis of their role relations and procedures of social control. Later formulations resulted in four crucial socialising contexts in the family:

> 'regulative', which positioned the child in the moral system, its backings and practices; 'instructional' which gave access to specific competences for managing objects and persons; 'interpersonal'; and 'imaginative' (Bernstein, 1990, p. 97)

The notion of semantic variation according to social class, gender, generation and sanity is supported through studies completed by systemic linguists (see Martin, 1992, p. 578). In particular, Hasan's (1986; 1990) study reveals different fashions of meaning in mothers' interactions with pre-school children according to gender and social class. In terms of mothers' control style, the characteristics of exhortative commands realised typically by imperatives, rationalisations through appeal to bribes and threats, demanding information using rhetorical how/why questions and the non-announcement of the commencement and conclusion of activities are found statistically more often in situations where the child was male and where the background of the mother was working class.

Bernstein's notion of semantic variation is supported in this study by the high level of immediate contextual dependency of both the oral discourse and the board texts of working class students in Lessons C1 and C2. In these lessons the meaning of the oral discourse depends to a much greater extent upon visual cues in the form of gesture and physical features of the context of the situation than in the other two lessons, particularly Lesson A. For example, the non-specificity of the patterns of reference in Lessons C1 and C2 means that the coherence of the discourse depends on accompanying non-verbal features of the immediate context. In addition, the board texts are essentially incomplete as texts. The hybrid, non-generic and ellipsed forms of representation mean that the written texts are only coherent in the context of the lesson. As I comment in the analysis, the texts would be near impossible to revisit. On the other hand, the meaning of the board text of Lesson A is not dependent on the immediate context of the lesson. It is essentially complete as an independent text.

The different fashions of meaning in the lessons relates to differential access to and participation in the discourse of mathematics. In particular, I suggest that the semantic orientation of the restricted code in Lessons C1 and C2 is directly opposed to the semantic orientation of the discourse of mathematics. That is, the orientation of particularistic/local/context-dependent meanings typical of working class discourse do not accord with the universal, remote and seemingly context-independent meanings of mathematics. The semantic orientation of the 'here-and-now' of working class students is fundamentally opposed to 'there-and-forever' orientation of the discourse of mathematics. I shall shortly return to this point in connection with

Halliday's (1985b) conceptualisations of the differences between written and spoken language.

As I have demonstrated in the analyses, the insights offered by systemic functional grammar reveal that the semantic differences extend further than those formulated by Bernstein. That is, there are fundamental differences in the semantic orientation of the interpersonal meaning in mathematical discourse and lessons of working class students and female students. For illustrative purposes I have summarised the features of interpersonal meaning of the discourse of mathematics and Lessons A, B and C1/C2 at the level of the register and language planes in Table 9.3 below. As this stage we may recall from Chapter 2 that interpersonal meaning has been referred to as 'the gateway to learning'. That is, one approaches the world through interpersonal relations.

To striking degree the interpersonal meaning of the discourse of Lesson A accords with that found in mathematics while the discourse of Lesson B and Lessons C1 and C2 occupies a marginal position. In other words, the female students and working class students do not construct interpersonal relations in which they are in a position of power. These students defer to the discourse of mathematics as to authority in general. On the other hand, male students are interpersonally positioned to engage with the dominating discourse of mathematics.

Table 9.3 Comparisons between interpersonal meaning realised in the lessons and mathematics

Dimension of Interpersonal Meaning	Middle/Upper Class		Working Class	Mathematical Discourse
	Discourse of Lesson A (Male students)	Discourse of Lesson B (Female students)	Discourse of Lesson C1/C2 (Male/female students)	
REGISTER				
Tenor	Visible control by teacher and unequal status, implicit equal status	Invisible control and unequal status, implicit unequal status	Invisible control and unequal status, implicit unequal status	Visible control and high status
	Orientated towards the individual (high student input)	Orientated towards the individual and group (minimal student input)	Orientated towards the group (moderate student input)	Orientated towards the individual

LANGUAGE: Discourse Semantics and Lexicogrammar				
POWER	Dominating	Deferential	Deferential	Dominating
	Interaction patterns of interpersonal congruence	Interaction patterns of interpersonal metaphor	Interaction patterns of interpersonal metaphor (except for commands in Lesson C2)	Interaction patterns of interpersonal congruence
	Minimal ellipsis	Moderate ellipsis	Maximal ellipsis	No ellipsis (excluding generic specifications for ellipsis in mathematical symbolism
	No paralinguistic behaviour or chorus responses	Moderate paralinguistic behaviour and chorus responses	High incidence of paralinguistic behaviour and chorus responses	No paralinguistic behaviour or chorus responses
	Extended interactions	Minimally extended interactions	Minimally extended/ extended interactions	Extended interactions
	Minimal tagging	Moderate tagging	Minimal/ moderate tagging	No tagging
	High values of modalisation	Relatively high values of modalisation	Relatively high values of modalisation	Maximal values modalisation
	High values of modulation	Relatively lower levels of modulation	Relatively lower levels /high levels of modulation	Maximal values of modulation
AFFECT	Minimal	Moderate	Moderate	Minimal
	Absence of exclamatives, minimal use of intensification, absence of diminutives, no displays of mental affection, no instances of Reacting	Few exclamatives, instances of intensification, diminutives, displays of mental affection, instances of Reacting	Exclamatives, intensification, few diminutives, displays of mental affection, instances of Reacting	Minimal expression with no manifestations of affect in symbolic text
CONTACT	Involved and non-intimate	Involved and minimally intimate	Involved and minimally intimate	Involved and non-intimate

Halliday's (1985b) formulations of the differences between spoken and written language are particularly instructive in connection with the meaning of mathematical texts and the semantic orientation of the restricted code of working class students. At this stage we should note that modern symbolic mathematics evolved as a written semiotic from written forms of language.

Halliday makes the point that speech and writing differentially represent reality. "Written language represents phenomena as **products**. Spoken language represents phenomena as **processes**" (Halliday, 1985b, p. 81). In other words, written texts construct a world of things and their relations while oral texts construct a world of happenings and processes. Halliday thus argues that written language presents a synoptic view of reality in which things are frozen in time. On the other hand, spoken language presents a dynamic view of reality where change is the key issue.

The meaning of mathematics is related to the costs which are involved in the synoptic and dynamic views of reality realised in written and spoken language respectively. Halliday formalises the former cost as "some simplifying of the relationship among its parts, and a lesser interest in how it got the way it is, or in where it may be going next (Halliday, 1985b, p. 97). On the other hand, the cost of the dynamic view is "less awareness of how things actually are, at a real or imaginary point of time; and a lessened sense of how they stay that way" (Halliday, 1985b, p. 97). I propose that mathematical symbolic descriptions are concerned with the dimensions of meaning which occur in the disjunction between spoken and written language. Following Lemke (forthcoming), this perhaps explains the evolution of mathematical symbolism as a semiotic which overcame limitations of language. Mathematics is concerned with relations of parts to the whole and as Lemke (forthcoming) formulates, with capturing continuous patterns of variation and covariation. These patterns reveal the status quo at different points of time. As written language is concerned with things, spoken language with happenings, mathematics is concerned with continuous descriptions of the happenings and relations of things.

As mathematics is a written semiotic which has evolved from written language to build direct links with visual display, it comes as no surprise that mathematical symbolism shares common characteristics with written

language. That is, the mathematical descriptions of relations are things which are frozen in time. In addition, as for the majority of written texts, mathematical descriptions are independent of immediate contextual parameters. Halliday explains that "... **in its core functions, writing is not anchored in the here-and-now** [my emphasis]" (Halliday, 1985b, p. 32). Writing is different from oral discourse as it evolved to fulfil particular functions which Halliday formulates as primarily for action, social contact, information and entertainment (Halliday, 1985b).

Significantly the restricted code is orientated towards the immediate context of here-and-now, unlike the semantic orientation of written texts. This may be opposed to the immediate context-independent semantic orientation of the elaborated code. It is this latter code, however, that realises valeur-laden spoken and written language genres including mathematics. For as Bernstein comments "*Agencies of symbolic control specialise in the production of specific discourses generated by elaborated codes*" (1990, p. 22). Although the restricted code realises written and spoken genres, these generally do not function as dominant discourses.

Halliday formulates the difference between the spoken and written language as relating to the type of the complexity involved in each form of discourse. As I demonstrate, Halliday's observations may be used to locate the type of complexity realised in mathematical texts.

> The complexity of the written language is static and dense. That of the spoken language is dynamic and intricate. Grammatical intricacy takes the place of lexical density. The highly information-packed, lexically dense passages of writing often tend to be extremely simple in their grammatical structure, as far as the organisation of the sentence (clause complex) is concerned (Halliday, 1985b, p. 87)

Halliday summarises the nature of written and spoken language as "density of substance" compared to "intricacy of movement" (Halliday, 1985b, p. 87). This reflects the different strategies which are involved in the encoding of meaning in written and oral discourse. Halliday formulates these as 'lexical density' and 'grammatical intricacy' respectively. With the former, the full potential of the nominal group for packing information is exploited in written language and more specifically in the language components of mathematical texts. That is, there are not only more 'content' words in written language texts, but information is also packed into nominal group

structures, which include clausal rankshift. Another strategy is grammatical metaphor whereby a shift in the function of elements occur. These commonly are cases of nominalisation whereby there is a shift from process to entity. On the other hand although spoken language is lexically less dense than written language, it exploits the potential of clause complex relations. That is, the systems of PROJECTION and EXPANSION at the level of the clause mean that processes may be represented in relation to one another and not just in isolation. Through this feature of spoken language, the dynamic coding of reality is possible.

The symbolism accompanying the language and visual parts of mathematical text exploits additional strategies for encoding meaning, as it is concerned with freezing in time the processes which give rise to the mathematical descriptions. The strategy involves complex nominal group structures which retain an orientation towards process through clausal rankshift. In addition to what is equivalent to extended nominal group structures, mathematical symbolism packs information through multiple levels of rankshift which involve embedded nuclear configurations. In written language, clausal rankshift is most commonly confined to a single level of embedding. This may be contrasted to mathematical symbolism which involves multiple levels of clausal rankshift. In essence, the form of rankshifted clauses means that an emphasis on process is retained. I believe that a new form of complexity is thus realised in mathematical symbolism. The lexical density realised by nominal group structures in written language is recombined with the grammatical intricacy realised by clause complex relations in spoken language to give a type of complexity which I shall call 'grammatical density'. That is, the multiple embedding of what I have called Operative processes and participants results in intricate grammatical structures which densely pack information. Mathematical symbolism exploits the strategies of written and spoken language while remaining embedded in the semantic orientation of written texts. In addition, the unique contributions of the three semiotic codes of mathematical symbolism, visual display and language occur in part through the process of semiotic metaphor whereby shifts in the functions of elements occur with movements between codes. These shifts mean that new opportunities for configurations of processes and participants arise as I have discussed in previous chapters.

We may note that the semantic orientation of the restricted code of working class students towards the here-and-now does not accord with the construction of reality in either the valeur-laden genres of written texts or mathematical texts. In particular, as displayed below in Figure 9.3, the semantics of spoken discourse which realises a restricted code is furthermost positioned from the written discourse of mathematics. These differences marginalise restricted code users in mathematics classrooms. In addition, the complexity of the discourses is different. This last observation may help explain the difficulties which the majority of the population experience in participating in mathematical discourse.

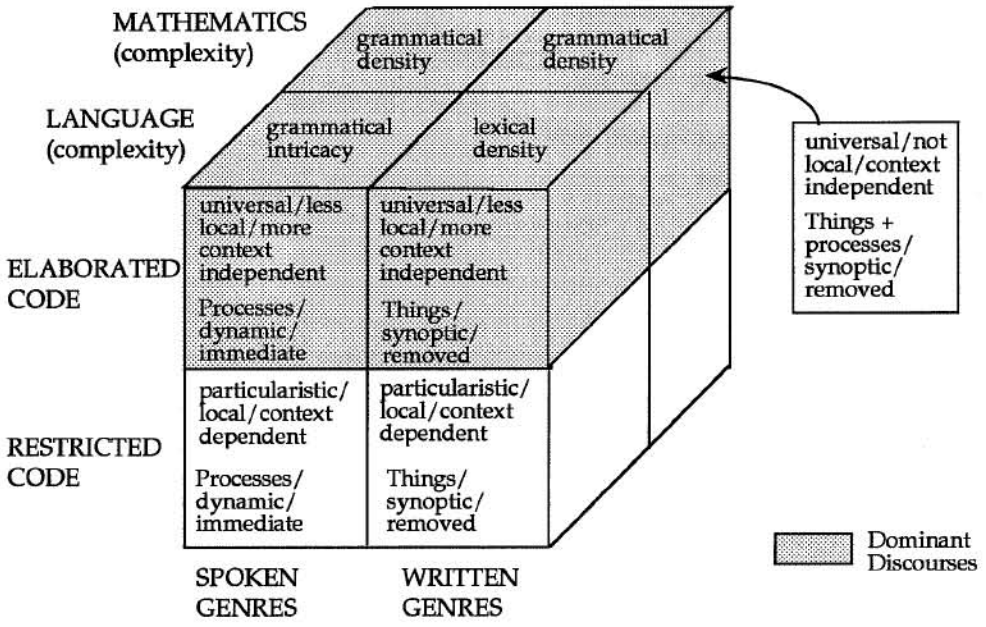

Figure 9.3 Semantic orientation of discourses

The accord between physiological perception and visual display allows access to mathematical constructions, but given the restrictions of meaning potential of this semiotic, ultimately the mathematical relations must be encoded in symbolism and supported by accompanying written language text. This means that in an educational context the students from working class backgrounds are disadvantaged with respect to access to the discourse of mathematics. Educational programs aimed at removing existing inequalities must be aimed at making explicit the semantic orientation of these texts and the strategies through which meaning is constructed in the different genres of mathematics.

9.5 Gender and Mathematics

Poynton (1985) summarises the differences in discourse according to gender as follows:

> In terms of gender, let us refer to the male **controlling code** and the female **responding code**, where males aim to control things, events, and most crucially people; and females show much more responsiveness to things, events, and particularly people. The consequences of such a difference in overall orientation are the continued resistance to the inclusion of women in access to real power and the continued marginalisation of those men who are not interested in power or control (p. 87).

Poynton's formulations accord with my analyses of the differences of interpersonal meaning in Lessons A and B. As I have previously commented, this means that while males are positioned to participate in the dominating discourse of mathematics, females are marginalised as a result of their overall orientation towards deference.

Poynton's comments raise the important issue of the marginalisation of men who do not display tendencies of domination and power. I believe that these men suffer as do the majority of men who are forced into masculine identities. Masculine-feminine oppositions such as reason-emotion, active-passive, instrumental-expressive, knowledge-ignorance, competence-incompetence, action-speech, culture-nature (Poynton, 1985, p. 18) place huge stresses on men who perhaps cannot act in accordance to personal need. In the context of this study, although the interpersonal dimensions of minimal affect and non-intimate relations realised in Lesson A make for a comfortable alliance with mathematics, the ultimate price of captivity in educational institutions such as School A is incalculable. This school is male and elite and functions on the basis of ideological constructions of what it is to be a man in our society. In a similar fashion, women suffer as a result of their experiences in educational institutions such as School B where female identities are reinforced.

The division based on biological sex in these elite institutions may be related to Foucault's conceptualisations of the place of sexuality in the operation of power. As Foucault (1980a; 1985; 1986) proposes, subjegation of individuals includes control through the constructions of sexuality. Although activities

such as eating and drinking receive much attention, none are so much cause for concern as the activities constituting sexual practices and construction of one's sexual self. True to his formulations of the operation of power, Foucault bypasses the repressive hypothesis of sexuality to "account for the fact that it is spoken about, to discover who does the speaking, the positions and viewpoints from which they speak, the institutions which store and distribute the things that are said (Foucault, 1980a, p. 11). In another words, Foucault is not concerned with the 'truth' of the discourse of sexuality and the idea of repression as a means of control, but rather the "way in which sex is 'put into discourse'" (Foucault, 1980a, p. 11). Foucault thus unveils the way the discursive practices surrounding sex operate for the production of power in the propagation of knowledge. He comments that:

> A first survey made from this viewpoint seems to indicate that since the end of the sixteenth century, the "putting into discourse of sex," far from undergoing a process of restriction, on the contrary has been subjected to a mechanism of increasing excitement; that the techniques of power exercised over sex have not obeyed a principle of rigorous selection, but rather one of disseminating and implantation of polymorphous sexualities; and that the will to knowledge has not come to a halt in the face of a taboo that must not be lifted, but has persisted in constituting - despite many mistakes of course - a science of sexuality (Foucault, 1980a, p. 12-13)

In other words, the discursive practices of sex function in the operation of power in much the same way as the discursive practices of science function to construct knowledge and fix truths. These discursive practices of sexuality include the maintenance and promotion of single sex educational institutions such as School A and School B. As I discussed in Chapter 1, Kenway's analyses of the discursive practices in the 1980s in Australia achieved closure around the virtues of such institutions. This separation focuses on sex as a key player in the discursive field of education. Sex is 'put into the discourse' as a damaging influence in educational achievement. It is instilled as natural that relations with the opposite sex are problematic and should be avoided if one has the capital to do so. On the other hand, relations with one's own sex are fixed as being of a different nature. In this discursive field, homosexuality is not admitted.

As I have shown in the analyses, one result of segregation based on biological sex is the reinforcement of different subject positionings according to the gender constructions which occur in tandem with this focus on sex.

That sex is elevated as an area of concern is clearly illustrated by the laughter which arose for the female student's reference to the "male teacher" who was enlisted for tutoring in Lesson B. By focussing on sex, individuals are firmly caught in a web of fictional truths concerning relations with others and constructions of their own sexuality which vary as subfields of gender constructions.

The notion of the benefits of segregation extends to co-educational schools where factions in mathematics and science education promote the advantages of separating girls in mathematics and science classrooms. Covertly, this functions to reinforce gender constructions, with the ultimate message that girls are vulnerable and need a protective enclave if they are to participate in the discourse of mathematics and science.

It is impossible to calculate the price which is paid for segregation in single sex schools with their reinforcement of gender constructions and explicit focus on sexuality. One may ask whether 'the science of sexuality' becomes the most single important strategy for control of these individuals for the rest of their lives. Foucault's conceptualisations reveal, however, that this science entangles us all.

9.6 Mathematics

Educational practices and the discourse of mathematics conflate in mathematics classrooms which consequently become critical sites for the operation of power. It is here that students are exposed to the thread which binds the commonsense of western culture. As Lemke (1995) points out, this commonsense born from the discourse of mathematics, science and rationality, is the product of a minority.

> Whose strategy for life produced this commonsense? ... The makers of our modern intellectual commonsense were Europeans. They were mainly upper class. They were mostly middle aged (for their times). They were nearly all males. They shared common intellectual problems, they belonged to social groups and communities that shared common political problems, and they would hardly have seen the one as being very much distinct from the other (p. 3).

Mathematics does not contain truths. It is a fashion of meaning that has proved extremely useful in western culture. This comes as no surprise as it

is a semiotic system which evolved in response to particular needs. Mathematics developed as a means of solving certain problems to the exclusion of others. This functionality underlies the valeur which is attached to the circumscribed ranges of meaning of mathematical discourse. It is a fashion of meaning that resonates with the orientation of particular members of society.

The elevated position of mathematics is secure. As I have demonstrated, access and participation in mathematical discourse is restricted to the few in secondary educational institutions. Because of the specialised systems for realising meanings, the discourse is impenetrable to outsiders. The discourse is also protected from within given the benefits that the enclave enjoy as a result of the position, status and utility of mathematics.

The problem lies not with the truth of mathematics, but in the discursive practices which have been constructed around mathematical knowledge. The construction of the regime of truth surrounding mathematics and science now extend beyond the boundaries of their initial conception. Mathematics and science legitimise practices in education, agriculture, commerce, medicine, politics, economics, law and indeed most areas of human activity. As Foucault maintains, the problem lies in the political, economic and institutional control of the production of this regime of truth. An institution that plays a critical role in this production of truth is the school. The disciplinary technology of the school means that the truth of individuals is fixed.

The limitations of this study reveal the need for the contextualisation of the meaning of mathematics. The systems and strategies for encoding meaning need to be comprehensively documented. The contributions of the semiotic codes of mathematical symbolism, language and visual display need description. The configurations of register variables realising specific genres of mathematics need documenting. The role of mathematics in the operation of power in contemporary society need explaining. I see this study as a first step along that path.

As much of the larger theoretical framework is based on Foucault's formulations, it is perhaps fitting to finish with one of his comments.

> ... by reaching the summit of all possible speech, he [man] arrives not at the very heart of himself but at the brink of that which limits him
>
> Foucault (1970, pp. 383)

Let us overcome that brink so that we may understand how things that appear so natural can be so damning.

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