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TITLE: Adult Numeracy, is it just an add-on to Adult Literacy?
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Introduction
Definitions of adult literacy current in Australia tend to include numeracy in the definition as an add-on to literacy:
Literacy involves the integration of listening, speaking, reading, writing and critical thinking; it incorporates numeracy.(Australian Council for Adult Literacy 1989)
This definition has striking similarities with a comment by Ryan in the entry on literacy in the first edition of the Encyclopaedia of Education (1985):
Since most literacy programmes provide instruction in numeracy, literacy will be considered here to subsume numeracy (Ryan 1985)
Numeracy emerges here as "the poor cousin of a poor cousin", with, it would appear, no identifiable pedagogical base.except as an add-on to literacy. The definition of literacy promoted by the Australian Language and Literacy Policy (1991) is somewhat more specific in the way that it positions numeracy in relationship to literacy when it states that "literacy also includes the recognition of numbers and basic mathematical signs and symbols within text" (ALLP 1991).
The current update of the entry on literacy and numeracy in the Encyclopaedia of Education (Baker & Street forthcoming) takes a rather different and more comprehensive approach:
The present entry...attempts to take account of both literacy and numeracy, devoting a separate section to each, as well as considering some of the similarities and differences between them (Baker & Street : Encyclopaedia of Education forthcoming)
Baker & Street propose an emphasis on literacy and numeracy as "social practices, learnt in specific cultural contexts and always imbued with epistemological significance".
This paper will argue, drawing on data from a classroom based study of the discourse of mathematics in TAFE numeracy classrooms, that, despite the undoubted area of overlap between literacy and numeracy work suggested by the ALLP definition and explored more systematically in a paper by Chapman & Lee (Chapman & Lee 1990), adult numeracy has its own theoretical and pedagogical bases and these are realized in classroom discourse in distinctive ways. From this perspective, learning numeracy from the very beginning can be seen as an apprenticeship in a "discourse community', involved in making mathematical meaning through language (and other related semiotic modes). The discourse community has its own distinctive orientations to meaning, some of them subject specific, others dependent on the ideological orientations of students and teachers.
Two senses of the term "discourse analysis"
In Sense One, discourse analysis involves what Stubbs (1983) calls " the linguistic analysis of naturally occurring connected spoken and written

discourse". It is an empirical investigation of the organization of language above the level of the sentence. I will not here go into the theoretical variants of the attempts to investigate language empirically above the level of the sentence, although the contrast between a linguistically accountable discourse analysis and a more sociologically oriented conversational analysis (cf the discussion in Eggins 1991) is clearly an important dimension.

In Sense Two, for example in the work of Foucault (1972) Kress (1989) Gee (1990) a discourse refers to the "systematically-organized sets of statements which give expression to the meanings and values of an institution"(Kress 1989:7), which define and determine what can or cannot be said. Discourses, in Foucault's sense, articulate ideological positions. Uses of language are not neutral, technical channels of communication, but are informed by deeply seated ideological positions, some explicit, some implicit. The relative dominance of certain genres of written language (cf Kress et al and the genre theorists) is "naturalized" within the education system. In Sense Two we can talk of the discourses of law, medicine and, as I hope to show in this paper, a discourse of mathematics which is part of the linguistic and ideological currency of the TAFE numeracy classroom.

Sense One discourse analysis is primarily derived from linguistics, while Sense Two discourse analysis is primarily derived from social theory, without a necessary accountability to linguistic data.

I will argue that, in Sense Two discourse analysis, it is particularly important to keep the analysis linguistically grounded, in other words to retain a concern for how Sense Two discourses are realized in Sense One discourse. Otherwise the concept of discourse analysis becomes a kind of free floating cultural criticism (cf Brumfit 1989) with no regularly observable connections to the uses of language in given contexts of situation (language as social process). The question here is how are discourses (medicine, law) realized in spoken and written language, in the genres of the medical consultation, the doctor's letter of referral, the solicitor's letter or the cross-questioning in a court of law. Gee refers to Sense Two discourses as discourses with a capital D. In the next section I will briefly review some relevant strands of classroom based research (Sense One discourse analysis) and will then go on to show how mathematical practices are constructed in discourse with a capital D and how the concept of the "discourse community" can be used to show how the TAFE numeracy classroom operates.

Investigating classroom discourse

Classroom discourse was from the beginning an object of linguistically based discourse analysis, perhaps because, as Stubbs points out "school lessons are a good place to start naturalistic observation of spoken interaction, since they are highly organized in some rather obvious ways" (Stubbs 1983: 40). Early work in discourse analysis (for example the Birmingham school cf Sinclair et al 1972)) investigated the exchange structure of classroom discourse, identifying some rather general properties of classroom discourse which have continued to be influential. Another important strand in the investigation of the ways that classrooms

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are constituted as social practice is classroom ethnography (cf Heath 1978, Green & Wallat 1980, Adelman (ed.) 1981, Cook-Gumperz (ed.) 1986, Roberts et al).

With very few exceptions (the work of Roberts et al in the UK on communication in multi-ethnic further education classrooms is one), the focus on classroom discourse has been school based, with little attention to the post school sector. In the area of TESOL, there is of course a considerable literature focusing on classroom discourse, mainly from an ethnographic or sense one discourse analysis perspective. In the area of Adult Basic Education, Grant and others have investigated the organization of Adult Literacy classrooms from an ethnographic perspective (Grant 1991), but we know of no studies which have systematically investigated the construction of mathematical practices in post-school classroom discourse. Ellerton & Clements' useful review of language factors in mathematics learning (Ellerton & Clements 1990) includes a section on Discourse Theory refer to such work but only in a schools context.Other work on mathematical discourse in the schools context is Walkerdine (1988) which achieves a Sense One and Sense Two perspective on mathematical discourse, Chapman and Mousley & Marks (1991).and Chapman (1992) which draws on linguistics, social semiotics and post-structuralist theory.

While Sense One discourse analysis and classroom ethnography have been good at showing us what makes classrooms classrooms, as distinct from any other type of social setting, they have so far not yielded a great amount of insight into the ways that particular subject/content areas are constituted in and through discourse and this has been the primary focus of the research on which I am reporting here.

The work of Lemke, drawing on systemic linguistic and ethnographic perspectives (Lemke 1982, 1983, 1985) addresses this issue as does the work of other of the genre theorists (Martin 1987, Painter & Martin (eds) 1986, Christie (ed.) 1990). The question is not so much what makes classrooms classrooms, important though this is, but rather how do the discourses of particular content areas operate in classroom discourse.

Lemke identifies two relevant dimensions for the discourse analysis of content areas in the classroom. One is the interactional construction of classroom discourse, covering openings and closings, topic nomination, the typical exchange structures of classroom discourse, the teacher's questioning strategies, students strategies for clarifying misunderstanding. The other dimension is the thematic development of the field of discourse :the what is being talked/learnt about.. Clearly the two dimensions are complementary. The present paper deals with aspects of the thematic development of the field of discourse, in particular the role of the transitivity system.

Bringing together Sense One and Sense Two approaches to discourse analysis, we are asking in what ways are mathematical practices constituted in discourse? We are looking for the ways that spoken and written language is constitutive of the making of mathematical meanings.

Discourses and Discourse Communities

The idea of the discourse community crops up in a number of contexts, for

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example in work on academic writing (cf Swales 1990). The concept of community brings with it ideas of membership and raises the issue of how people come to be members of a given discourse community, through what processes of socialization. Gee describes it in this way:

social practices, Further these social practices are never just language or literacy practices. They always also involve ways of acting, interacting, being, thinking, valuing, believing, gesturing, dressing, using various 'props' (books, paper, notebooks, computers, rooms and buildings, etc.), as well as ways of using language (written or spoken). I have called these integrations of ways of being-doing-thinking-valuing-speaking-listening (-writing-reading)'Discourses'.

Each Discourse is tied to a particular social identity and to certain social settings and institutions. Each is a form of life, a way of being in the world, a way of being a 'person like us', in terms of actions, interaction, values, thought and language, whether this is people in our family, classroom, school, local drinking group, church, nation, ethnic group, sewing circle, business, job site, profession, gender, peer group, gang, and so on through a very long list (Gee 1990:174-5)

In this paper I will focus on some aspects of the uses of language involved in being part of a mathematics discourse community, in particular, as it happens on the "being-doing-thinking-valuing-speaking-listening (-writing-reading)" as it is encoded in selections from the transitivity system of English in the discourse of teachers and students in two TAFE numeracy classes.

I will argue that becoming a member of an adult numeracy class involves an apprenticeship in a mathematical discourse, seen as a set of ways of making mathematical meaning in and through language (and other semiotic modes), that from the most "basic" level it is not possible to make mathematical meaning without being part of that discourse community. In this sense the mathematical discourse is constitutive of mathematical practices.: you literally can't do mathematics without engaging in it.

On not being part of a mathematics discourse community

The following extract from an article entitles "Workplace Illiteracy" (Zemke 1989), rather dramatically, if unconsciously illustrates the consequences of not being part of a mathematics discourse community:

I'd ordered a large coffee and a bran muffin to go. The tab came to $1.86. As on a hundred previous mornings, I tossed two crumpled singles onto the counter. The cashier, long-accustomed to snatching up moving money, flicked a thin arm across the counter top and began the simple cash transaction sequence. "Wait", I mumbled, "I gotta get a paper. Let me give you two nickels and a penny."

Since I normally don't blink, much less talk, before my third cup of coffee, she was understandably startled. "Huh? What? Excuse me?"

"I need change for the newspaper machine, so I'm giving you 11 cents more".

The seconds passed. Eventually, a glimmer of understanding appeared, along with a look of abject horror. Her jaw went slack. Her mouth dropped open. She stumbled back a half step and might have fled the scene had it not been for the wall at her back.

"You, you want me to make change?" she stammered. "But I already rang up

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the coffee and the roll. And the register told me to give you 14 cents change."
"I'm sure. But I need a newspaper. So I'm giving you 11 cents to go with the 14 cents you owe me. That way you can give me back a quarter so I can have a quarter to put in the newspaper machine."
"You want me to give you a quarter so's you can buy a paper?" she asked.
"If it's not too much trouble."
"Oh. eleven and 14,. That's a quarter right?"

"Right"
"But I already rung it up,ya know. So if I give you a quarter, I'll be short at the end of the shift. Won't I? Like, I will be, won't I?"
"On second thought, forget it. I'll listen to the radio".
After this anecdote, Zemke continues ' I had run smack up against "innumeracy" the educational in-crowd's term for numerical illiteracy.. John Allen Paulos, a professor of mathematics at Temple University, defines the phenomenon as "an inability to deal comfortably with fundamental notions of numbers and chance" '.
Zemke, perhaps unconsciously, uses the resources of narrative to construct the non linguistic, socio-political dimensions of Gee's Discourse: membership (the club of people who can do basic calculations) is defined be its opposite, the people who can't. Non standard language forms "ya know", simple repetitive work processes (Para One) , lexis related to physical appearance, intelligence and stance ("a thin arm"," a glimmer of understanding", "her jaw went slack") are constructed as narrative devices to position the "neighbourhood coffee-and-rolls lady" in a particular socio-economic class and occupational range and as a non member of the mathematics discourse community (presumably inhabited by the author and the professor of mathematics at Temple University).
As it happens the participants in this incident also introduce some of the transitivity choices typical of mathematical discourse, which will be discussed in more detail below. Take the following:
1) Oh. Eleven and 14. That's a quarter, right?
2) So I'm giving you 11 cents to go with the 14 cents you owe me. That way you can give me back a quarter so I can have a quarter to put in the newspaper machine.
3) So if I give you a quarter, I'll be short at the end of the shift.
4) And the register told me to give you 14 cents change

1), in highly spoken mode, is an instance of the relational process (cf Halliday 1985, Matthiessen 1991), in which the process relates two participants as Token and Value. This becomes clear if we remove the spoken-like thematization of 1) for the sake of simplicity of analysis and examine a clause like:

Eleven and fourteen	is	a quarter
Token	Process	Value

Matthiessen (1991) argues that relational processes of this sort are basic to the construction of semiosis. They are certainly basic to the construction of mathematical arguments.as we shall see in considering the data from the TAFE classrooms.

Suppose for the sake of argument, we substituted "makes" for "is" in the above clause.

5) Eleven and fourteen makes a quarter

We have overlaid, as it were, a material process on the relational one, since we would have to see 5) as an instance of grammatical metaphor, albeit one that is highly commonplace in mathematical arguments (as in "one and one makes two.")

2) shows the role of material process in basic mathematical operations ("giving", "giving back").albeit of a very concrete nature: the context allows one to conceive of money literally changing hands. We will see in the TAFE data the place that material process has in construing mathematical practices although,as we shall see, the referents are generally more abstract than in this example..

2) also provides an example of causal-conditional connectivity, in this context realized paratactically ("you can give me back a quarter so I can have a quarter to put in the newspaper machine") which is an important feature of mathematical discourse.

3) provides an instance of causal conditional logical connectivity, that is virtually canonical in the discourse of mathematics (IF THIS THEN THAT). The if clause is a material process type "I give you a quarter", while the main clause (the result) is a relational process "I'll be short".

4) is an instance of a clause type that is very common in one of the classrooms considered in this paper. Matthiessen (1991) points out, following Halliday (1985) that verbal processes, while typically involving human participants:

The manager	told	me	to give you 14 cents change
Sayer	verbal process	addressee	
a Reporting			b Reported

can just as typically, by a form of semiotic extension, take non human participants in the Sayer role, provided these participants can be interpreted as semiotic sources (books, documents, articles, programmes etc). In this case the cash register is the Sayer/semiotic source:

The register	told	me	to give you 14 cents chang
Sayer/ semiotic source	verbal process	addressee	
a Reporting			b Reported

The role of the register as Sayer seems to emphasize the powerlessness of the cashier (who is told) against the register (which tells).

From this small text, we have been able to extract a number of process types which, I will argue, are fundamental to the construction of mathematical meanings in discourse. They are constitutive in the sense that making mathematical meaning would not be possible without them (I am leaving out of consideration here the making of mathematical meanings for example within a visual semiotic).

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In terms of Gee's "being-doing-thinking-valuing-speaking-listening(-writing-reading)" chain, we might say that the discourse of mathematics particularly selects being-doing-saying. In the two classooms which we are about to consider, the balance between being-doing-saying is somewhat differently weighted.

The two classroom contexts

The data for this paper is drawn from a corpus of data from a range of TAFE numeracy classrooms. The classrooms were videotaped and audiotaped with additional observational notes. The two classrooms considered here were selected because the teachers, both coming from rather different teaching backgrounds: one teacher (referred to as Teacher A), had come to numeracy teaching via literacy teaching and women's education. She has a postgraduate qualification in teaching Adult Basic Education, but no specialist maths training. The other teacher (Teacher B) had come into adult basic education work from primary school teaching and had studied maths at tertiary level as part of her teacher training. Both teachers appeared to be operating with rather different pedagogic styles. This paper is an attempt to come to grips with the ways these pedagogic styles might be realized in classroom discourse, but first it is necessary to characterize the constitutive features of the discourse of mathematics itself.

The scope of the project is to build up a complex picture of the mathematical discourse in these classrooms as they are realized in a number of interrelated linguistic systems. This paper will deal with aspects of the transitivity system.

Transitivity in mathematical discourse

The analysis of transitivity used here is derived from Halliday (1985) and Matthiessen (1991). According to Halliday: "transitivity specifies the different types of process that are recognized in the language, and the structures by which they are expressed" (Halliday 1985: 101). The main process types are as follows:

- material process: "doings and happenings"
- relational process: "being and having"
- verbal process: "saying"
- mental process: " thinking/knowing/feeling"

The traditional classroom definition of the verb as "a doing word" istherefore relates most clearly to the notion of verb as material process. Matthiessen (1991) presents an analysis of the grammar of semiosis, the self-referring capacity of language which is most typically realized in the grammar of the relational process which construes a Token-Value relationship between participants:

"John bit the dog" is a material process.

As Matthiessen points out, the Token-Value relationship is constitutive of any semiotic activity, including linguistic analysis. It is also, of course, constitutive of mathematical reasoning:

10/2 is an improper fraction

If relational process is constitutive of the semiotic (and mathematical) relationship, it is not the only way that semiosis is realized in the

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grammar. Mathiessen (1991) explores a variety of ways that semiotic motifs are dispersed through the grammar. For the purpose of this presentation we will focus on one other: the use of verbal process to enact semiosis.
Verbal process can have a human subject as the principal participant:
And here Jenny said you can change it into a fraction.
In addition to the congruent human subject type of verbal process, Halliday points to a semiotic extension of the verbal process type to include "semiotic sources": entities that can themselves plausibly generate meanings (books, newspapers, reports and, as we shall see calculators, tape-measures and cash-registers). We have in fact already come across an example of this type of verbal process in the clause:
and the register told me to give you fourteen cents change.

Transitivity in the classroom data
We have already introduced informally some aspects of the typical transitivity choices of mathematical discourse above. Here we will do it more systematically using data from the two classrooms.
Material process: mathematics as doing
Material process is the process type which realizes mathematical operations: a series of transformations performed for example on numbers to achieve a given result:
Take your whole number (writing x between the 2 and the 7) multiply it by the ss (pointing to the seven) the bottom number, so it becomes two lots of 7,'s14 and then add on the 3 (writing + next to the 3)
(Classroom B)

"Take", "Multiply","Add" all specify mathematical operations as material processes.
Relational process: mathematical meanings
Given the discussion above on the grammar of semiosis, it makes as much sense in this context to talk of the semantic domain of intensive attributive relational process as "meaning" rather than "being". In the data cited above, we see the role of relational process in mathematical discourse as giving the "result" of a series of mathematical operations:
it becomes two lots of 7
's 14

The grammar of relational process, expressing meanings, emphasizes mathematical practices as the production or creation of meanings.
Expressing result as material process
The grammar has resources for expressing result as material process:
So you get 17 over 7
or indeed for skewing the congruence of the material process by making it into a relational process:
What you've got is two whole pies
So this is what you've actually got
The material process typically construes mathematical practices as

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operations, performed by the mathematical subject who (as we shall see below) is also constructed in discourse.It construes mathematical practices as activity.

The outcome of the activity is a result, which can be expressed as a meaning, so the interrelationship between doing and meaning emerges as a close one. However, when we look at the contrasting pedagogical styles of Teacher A and Teacher B, we will consider whether one dimension of this (certainly not the only one) is the extent to which mathematical practices are constructed in discourse as doing or meaning. In order to take this further we need to look at verbal process as the enactment of semiosis.

Verbal process as the enactment of semiosis

As we pointed out above, verbal process can have a human subject or a non-human semiotic source as principal participant. We will look at both categories in turn.

Verbal process with a human subject as principal participant

Ok, mathematically what Ruth and some of the others were doing, they - they were saying, what number will go into the top number and to the bottom (draws a circle round the 5 in 7/5) And you say (writing the dividing sign followed by 5 at the side of both the 7 and the 5 in 7/5) how many fives in five?

(Classroom B)

What Jenny said here is if you have a number after the point it is less than a whole

And here Jenny said you can change it into a fraction

(Classroom A)

We are able to link these projections back to preceding discourse and compare them to the original utterances of the students:

Ruth/ Five out of five is one and the two..you just (shrugs)...you can't do anything with it, so you just put it over five

Diane/ There's two let so you then - you use the five as the bottom number,

Jenny/ Decimals are usually where the point's in front

T/ mm mm

Jenny/ And you have numbers after it so it's not a whole number.

Jenny/ Sometimes decimals can be - you can make a decimal into a fraction...you can change it

What the teacher is doing in reporting the students' contributions is typical of what is traditionally known as "indirect speech reporting" in which the projected clause is a meaning not a wording. Both teachers are shifting the students contributions in the direction of mathematical discourse.(cf the similar use of the concept of discourse shift in Chapman 1992)

A rather general marker of mathematical discourse, used by both teachers and students is in the pronoun selection in the clause:

You say how many fives in five

"You" here has a generic or generalizing reference, meaning not "you" the conversational partner, but anyone engaged in mathematical reasoning. What is at work here is the creation of the mathematical subject in discourse.

Another indication of this shift is in the following:

mathematically, what Ruth and some of the others were doing, they - they were saying

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which can be glossed " as participants in a mathematical discourse community, what Ruth and some of the others were doing/saying was.......".
The teacher's hesitation and reformulation of doing to saying reiterates the tension between mathematical practices as activity and meaning.
The way in which the teacher reformulates the student's initial utterance

below is an illustration of the shift towards mathematical discourse.
Jenny/ And you have numbers after it so it's not a whole number.
What Jenny said here is if you have a number after the point it is less than a whole

Verbal process with non-human semiotic source as principal participant
Whenever you're asked to actually divide a shape up. It's actually easier to do it like this (indicating the rectangle) Some people try and get fancy and divide it of into other shapes (gestures globe shapes). It gets very hard to keep them relatively equal in size. So tip number 1, if you get a question that says divide this shape up into fifths, this is one of the easier ways of doing it
(Classroom B)
There are two versions of this verbal process which projects a request. In the first the asker is elided, so that it could be either a human subject or a non human semiotic source. In the second the question itself is the principal participant.
So what do you do then when you get a sum that says a quarter plus a third?
(Classroom B)
Again we see the "wording" feature of the "sum that says a quarter plus a third" which is clearly expressing a meaning projected by a semiotic source "the sum".
Both these examples are taken from Classroom B, where they are in fact relatively uncommon. Verbal process with non-human semiotic source as principal participant is much more typical currency in Classroom A and we will discuss the implications of this when we examine evidence for contrasting pedagogic styles in Classrooms A and B. All the process types considered so far are found in both classrooms and can be regarded, in their own ways, as constitutive of mathematical discourse, yet preliminary observations indicate that they are distributed in markedly diferent ways in each classroom and that Classroom B has an orientation to mathematical practices as action, reflected in relatively more frequent selection of material process, while classroom B has an orientation to mathematical practices as meaning making, reflected in the relatively more frequent selection of semiotic process.
this sheet here which just has the words decimals on it, I'd like you to have a look at them and talk among yourselves as a group.....Have a talk amongst yourselves and then see what it's telling you and see if you can answer...the questions, right?
(Classroom A)
Lyn/(pointing to what Susan has written) That's one tenth, this is two tenths, four tens -th
Susan/ (laughs) Yes

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Lyn/ Allright so that says four tenths there
Susan/ So here you go four, and here you go oh point four....and this one here is nine tenths
(Classroom A)
Lyn/ Because we done it in our heads...'cos we done it you know
Kerry/ Because we had a go at working it out without using a calculator
Lyn/ And if you do it back to front on here, it's like if you go ten divided by one you get the same answer for them both
T/ Yes. because you're saying ten, I've got ten and I'm going to divide it by one, and what we're really saying I've got one, one tenth, so I have to divide the bottom part into the top part (gesturing with one forearm horizontal as the dividing line, indicating bottom into top with another hand). Because, when the bottom part of your fraction, which has a specific name, denominator (picking up a flat, pointing to it with a forefinger) the denominator at the bottom tells you how many parts you cut your fraction into (making a circular movement over the surface of the flat). Allright? And the numerator(holds a long in the air above the flat) which is the part at the top, tells you how many pieces you pick up, or how many parts of it you shade in.
(Classroom A)
The first three examples of verbal process in this text (incuding an example of non-standard "go") have human subjects In the final two, which count as attempts to explain the function of the numerator and the denominator, albeit within the frame of the current activity, the numerator and the denominator themselves are the semiotic sources.

This type of verbal process is relatively common in Classroom A discourse, certainly as compared to its occurrence in Classroom B discourse. Here are some other instances:
On the bottom of one of your worksheets it talked about using your calculator, Ok? And it says use the calculator to find one tenth and it gives you all the instructions, it says one divided by ten equals?

T/so, when you just see that, it looks as if its hieroglyphic so that's very difficult to do, but what they've basically said is I've taken a part of the tape measure and part of it says this is the whole number the metre and the rest of it is divided into metres, part of the metre and remember the decimal (pointing to decimal point on board) is talking about part, the part.
(Classroom A)
These extracts show a rather rich semiotic texture achieved by the use of verbal process, projecting both wording and meaning. The use of semiotic sources to project wordings and meanings in this way make decimal points, nominators and denominators mean (in the active sense that Halliday has made current) and that meaning is enacted by making them say, tell, talk.it.

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Transitivity choice as evidence of contrasting pedagogical style

It was suggested at the beginning of this paper that the two teachers selected for analysis had rather different and contrasting pedagogical styles. The linguistic analysis presented was designed to describe the typical transitivity choices of mathematical discourse in general and to provide the basis for a systematic comparison of transitivity choices in the two classrooms to see if differential selection from the transitivity system could account for some aspects of pedagogical style.

The dimensions of pedagogical style selected were on one hand a pedagogical style that emphasized mathematical practices as activity and on the other a pedagogical that emphasized mathematical practices as meaning construction. It is important, however to remember that the dimensions of activity and meaning construction are basically complementary and that differences in pedagogic style and classroom discourse are therefore likely to be differences in emphasis rather than absolute differences.

We have already seen how the Classroom A and B teachers contrast in the quantity and type of semiotic process evident in their discourse. We will conclude by looking at similarities and differences in the way they approach:

a) the definition of the terms "numerator" and "denominator"

b) discourse concerning the use of the calculator.

Defining "numerator" and "denominator"

T/the denominator at the bottom tells you how many parts you cut your fraction into (making a circular movement over the surface of the flat). Allright? And the numerator(holds a long in the air above the flat) which is the part at the top, tells you how many pieces you pick up, or how many parts of it you shade in.

(Classroom A)

The Classroom A teacher defines "denominator" and "numerator" semiotically as meaning which is projected from the terms as semiotic source. The projection is however highly contextualized into the ongoing situation (a diagram showing the division of a rectangle into ten equal parts). These count as definitions, but they are definitions that are highly context bound.

Jenny/ (to Warren) She got - and she said the top one (points to the numerator she wrote which Warren is holding) is how many (points to several red halves in the line) ...thing and the bottom one (points to denominator) is what it is

(Classroom A)

Jenny's definition is framed in terms of relational process. She does not use the terms numerator/denominator, but rather top one/bottom one.

T/You need to say what number will go into the top number and also in the bottom number...and do that as a divide. So the first one says 8 over 16.

(Classroom B)

The Classroom B teacher uses top number/ bottom number virtually throughout, but is drawn to a definition of numerator/denominator by their appearance on a work sheet:

T/ Anyway up in the heading here, there is a word that you don't know. Does

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it make any sense to anybody? Do you know what a denominator is?
SS/ Yeah the bottom number. The bottom of the fraction.
T/ Oh well, that was easy then. Ok what's the top number of a fraction?
SS/ Numerator.

This definition is jointly constructed by teacher and students (who know the meaning of the words). they are also of the relational process type.

Using the calculator

Earlier in this paper we discerned two different, if complementary orientations to meaning with regard to mathematical practices. The first constructs mathematical practices as the production or creation of meanings, the second constructs mathematical practices as activity. We argue that in the realization of the first orientation to meaning, the role of semiotic process will be qualitatively and quantitatively greater, while in the second, material process will be foregrounded.

The following extracts from Classroom B and Classroom A discourse focus on the use of calculators. We will examine them to see the ways that the two teachers construct interactions with the calculator, paying particular attention to the role of material process and the quality and quantity of semiotic process.

For clarity of presentation material process is marked in bold, semiotic process in italics. For further clarification semiotic process that is realized as verbal process (the enactment of semiosis) is marked in underlined italics.. Mental process is marked by outline.

T/ People if you're using your calculator, and you want an answer in a fraction, you must use the fraction button in your question. If you don't, you'll end up with a decimal answer and it won't make sense.
(Classroom B)

In the above extract, Teacher B is giving instructions in the use of the calculator. In a sense it is all about semiosis and there are a series of explicit mentions of semiotic items , such as ("an answer in a fraction"..........."question"................."a decimal answer".............."make sense") yet throughout, material process is also foregrounded ("using"........"use"........."end up with"). The overall effect of this is to construe semiotic process as material process, in a manner reminiscent of the way that speech act theory is characterized as "doing things with words". This effect is achieved through a combination of lexical items referring to speech act functions (question/answer) with material process verbs (use/end up with).

Teacher B concludes the above extract with the phrase "it (i.e. the decimal answer) won't make sense" which occurs frequently in her discourse glossing as it were the semiotic underpinning of the mathematical practices. In contrast Teacher B tends to enact semiosis with utterances like " see what its telling you". In other words both teachers have a commitment to mathematical practices as meaning making, but this is realized in rather different ways in their discourse. The differences between these classrooms are differences of emphasis or degree rather than absolute differences.

In the following extracts the material process orientation of Teacher B's instructions on the use of the calculator come through very clearly. The emphasis is on the mechanical operations which produce meanings, rather than the meanings themselves.

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T/ Four eights are 32. How would you do it on your calculator?
S/ You just put the 20 32 and you calculate and you press equals and it comes out.
T/ Twenty, your fraction button
S/ Yes
T/ Which is the a over c button
S/ And then thirty two
T/ Thirty two
S/ Then equals
T/ Then equals
S/ And the answer comes
T/ And it will actually show the answer for you. Ok? Try doing that with your calculator. Right? Twenty, fraction button, thirty two and then equals

(Classroom B)

T/ When you're doing fractions that have got more than 3 numbers at the bottom, the calculator won't accept it. So, therefore, you need to try and break your sum down at least one step before you put it into the calculator. You can either put it in straight like this (lalling, indicating the button sequence for 9/27 x 3/72) it will do this for you, but if you try and punch just this in (indicating 27/1944) to get it to break down in the calculator the calculator will not accept one nine four four
(Classroom B)
In contrast to the Classroom B extracts, the Classroom A teacher embeds the procedural activity of showing students how to complete a worksheet with a number of clauses in which verbal process is attributed to a semiotic source: the worksheet.
T/ On the bottom of one of the worksheets it talked about   using your calculator, ok? And it says use the calculator to find one tenth and it gives you all the instructions, it says one divided by ten equals?
Gay/ (   ) one. I did it wrong.
T/ Wait (looking at her calculator) no, you didn't do it wrong.
Kerry/ Oh point one

Gay/ Oh, oh point one
T/ Oh point one, ok? So, use - do all of those ones and see what happens
Gay/ So we write it down the same as it comes up on the calculator?
T/ Write down what it comes up on the calculator and then we'll talk about what's going on.
(murmuring)
(Classroom A)
Teacher A's discourse juxtaposes the material process + speech act function reference of:
it gives you all the instructions
which we noted in the discourse of Teacher B, with the subsequent enactment

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of semiosis, in which the worksheet is made to speak:
it says one divided by ten equals?
The above extracts seem to confirm the different orientation towards mathematical practices in the discourse of Teacher A and Teacher B. Teacher A is likely to "semioticize" even a brief procedural activity like a worksheet, by dramatizing the procedures with the worksheet as semiotic source. Teacher B on the other hand shows a distinct preference for material process and, even when the field of discourse is highly semiotic, (i.e. questioning the calculator and getting answers), uses the resources of the grammar to highlight the "doing things with words" dimension of verbal process, to "materialize" verbal process as it were.
Some preliminary observations on the distribution of process types in the data
The above remarks are derived from a qualitative analysis of features of the classroom discourse. It will be noted that another process type typical of mathematical discourse is not considered here: mental process, in particular perception "seeing" and cognition "thinking.
It was also noted that all process types featured in both classrooms, the apparent difference being the frequency of occurrence. Thus, for example, verbal process with a semiotic source as sayer crops up half a dozen times in Classroom B, whereas it is a much more recurrent feature in Classroom A. Preliminary observations would indicate that material process ("doing") is by far the most common process type in both classrooms, followed by relational process ("meaning"). Verbal process, seen as enactment of semiosis would be a key variable in differentiating between the pedagogic styles and classroom discourses of the two settings, both in terms of quantity (The Classroom A teacher using more tokens of verbal process than the Classroom B teacher) and also in terms of quality (The classroom A teacher using a wider range of resources to enact semiosis.) In addition the Classroom B teacher has a tendency to "materialize" semiotic reference with a combination of material process and lexis referring to speech act functions.
Both teachers make explicit commitment to mathematical practices as meaning making, but again in rather different ways. The classroom A teacher typically enacts semiosis, "see what it's telling you" , while the classroom B teacher emphasizes mathematical practices as activity, glossed with the promise that "it'll make sense".
Conclusion
At the beginning of this paper we pointed to definitions of literacy that subsumed numeracy, arguing instead for definitions of literacy and numeracy that emphasize both continuities and discontinuities, similarity and difference. The data discussed in this paper should make clear that engaging in mathematical reasoning involves complex uses of language which are constitutive in the sense that you couldn't engage in mathematical practices without them. It is this that we term mathematical discourse. The learners in both classrooms were engaged in an apprenticeship in this discourse.
In addition, a close examination of the linguistic texture of the discourse in the two classrooms revealed systematic differences in their orientation to mathematical practices. In Classroom A there was a quantitatively and

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qualitatively greater emphasis on mathematical practices as the creation/construction of meanings. In Classroom B there was a greater emphasis on mathematical practices as activity. We would therefore argue that different orientations to maths as activity or meaning-making may be

an important dimension of pedagogical style.and ideological position.
A fuller understanding of how these classrooms are constructed in discourse will depend on other analyses of the data currently being carried out, looking at features such as exchange structure, the schematic structure of the classroom discourse, the creation and maintenance of interpersonal relations, the interrelationship of spoken and written language with the visual semiotics of diagrams and mathematical symbol systems. However, the analysis of transitivity choices in classroom discourse has provided clear evidence of some of the constitutive features of mathematical discourse and some initial indications of rather distinctive orientations to mathematical practices.

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