ANALYSING CLASSROOM INTERACTIONS USING CRITICAL DISCOURSE ANALYSIS

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There is a long history of studies of language and mathematics. Much of this has focused on the language of mathematics, and the role of language in developing mathematical understanding. A more recent emphasis has been on how language in the mathematics classroom illustrates power relationships. In this study we use the tools of critical discourse analysis, including systemic functional linguistics, to examine the extent to which student agency is promoted and evident in a year 8 mathematics classroom in Australia.

There is a long history of studies of language and mathematics. Pimm (1987) suggests that there are three levels of relationship: mathematics and language, the mathematics of language or conversely the language of mathematics, and mathematics as a language. Zevenbergen (2000) discusses mathematics as a register with its own specialised vocabulary, semantic structure and lexical density. She maintains that language is a form of cultural capital, and suggests that students must learn to ‘crack the code’ of the mathematics classroom, a task which is less accessible to students from working class backgrounds than to students from middle class backgrounds.

A second emphasis, particularly in the constructivist literature, has been the role of language in learning mathematics. Brown (2001) points to the role of language in developing understanding, noting that mathematics can only be shared in discourse, mediated through social events. Alrø and Skovsmose (2002) stress that the quality of communication in the classroom is inextricably linked to the quality of learning, and discuss the role of dialogue in the learning of mathematics. In contrast to lessons containing genuine dialogue, many traditional mathematics lessons amount to little more than a game of ‘guess what the teacher thinks’ (Alrø & Skovsmose, 2002).

A more recent area of focus on language in mathematics has been on how language in the mathematics classroom illustrates power relationships (Walkerdine, 1988; Zevenbergen, 2000). In a set of papers edited by Barwell (2005), bringing together the fields of mathematics education and applied linguistics, several writers considered issues such as the nature of academic mathematical discourse, and the relationship between the teaching and learning of mathematics and students’ induction into mathematical discourses. They claim that a view of language as a social practice is inseparable from a view of mathematics as social practice.

In this study we use the tools of critical discourse analysis to examine the extent to which student agency is promoted and evident in a year 8 mathematics classroom.

CRITICAL DISCOURSE ANALYSIS (CDA)

Critical discourse analysis emerged in the 1980s as an attempt to synthesise language studies and social theory (Fairclough, 1992). It looks critically at the nexus of language/discourse/speech and social structure, attempting to uncover ways in which social structure impinges on discourse patterns and power relations (Blommaert & Bulcaen, 2000). It thus has the potential to look beyond superficial aspects of classroom language, and to illuminate aspects of agency (Boaler, 2003) and power in the classroom.

Fairclough (1992) considers discourse as a mode of action in which people act on the world and each other, in addition to being a mode of representation. He stresses that there is a dialectic relationship between discourse and social structure, with discourse on the one hand being constrained by social structure, and on the other as being socially constitutive. He sketches a three-dimensional framework for conceiving of and analyzing discourse, considering “every discursive event as being simultaneously a piece of text, an instance of discursive practice and an instance of social practice” (p4).

The first dimension is discourse-as-text, i.e. the linguistic features and organization of concrete instances of discourse. Building on the work of, for example, Halliday (1978), Fairclough maintains that text analysis must include a consideration of vocabulary, grammar, cohesion and text structure.

Fairclough’s second dimension is discourse-as-discursive-practice, i.e. discourse as something that is produced, distributed and consumed in society. He introduces the concepts of ‘force’ to describe what the text is being used to do socially, ‘coherence’ to describe the extent to which an interpreting subject is able to infer meaningful relationships and to make sense of the text as a whole, and ‘intertextuality’ to describe how texts are related historically to other texts (p 83).

Fairclough’s third dimension is discourse-as-social-practice, drawing on the Marxist concepts of ideology and hegemony. He claims that ideology is located both in the structure of discourse and in the discourse events themselves. For example, he suggests that the turn-taking practice of a typical classroom implies particular ideological assumptions about the social identities of and relationships between teacher and pupils (p 90). Hegemony concerns power that is achieved through constructing alliances and integrating groups. For example, in the classroom the dominant groups exercise power through integrating rather than dominating subordinate groups, winning their consent and establishing a ‘precarious equilibrium’.

Fairclough claims that this framework ‘allows one to combine social relevance and textual specificity in doing discourse analysis, and to come to grips with change’ (p 100)
THE CLASSROOM

A transcript from a year 8 lesson (“Noemi’s classroom”) is provided in Appendix 1. This transcript is representative of the pattern of discourse observed throughout the lesson. The classroom atmosphere is relaxed and friendly, with a productive working relationship between students, and between the teacher and the students.

In Noemi’s classroom the students are exploring the mathematical concept of gradient, and attempting to discover for themselves the effect of changing $a$ in the equation $y = ax + b$. They have drawn graphs using two or three numerical values, and are reporting to other students in the class on their findings. Students take it in turns to walk to the front of the class and sketch graphs on the whiteboard, explaining to other students what they have discovered, and responding to what other students have said.

ANALYSIS OF THE DISCOURSE

Fairclough’s (1992) three-dimensional framework is used to analyse and compare the discourse in the two classrooms.

Discourse as text

We discuss the field, tenor and mode of the text (Halliday, 1978), thus looking at the ideational, interpersonal and textual functions of the discourse (Morgan, 2005).

The field of discourse is overtly mathematics, with few, if any, diversions. In contrast to the patterns of interaction observed, for example, in the TIMSS 1999 video study (Hollingsworth et al., 2003), the teacher intervened only to regulate the conversation (“One at a time, please” – Teacher), and to suggest things for the students to think about. In Noemi’s classroom the discourse is concerned with mental processes, the conversation being dominated by statements such as “I think”. On the other hand in many traditional classrooms the emphasis is on material processes or the creation of a product such as a solution to a problem. In Noemi’s classroom the discussions are public rather than private discussions, with students laying open their reasoning for public debate and potential criticism. There is a predominance of self and other questioning (“I was wondering…” – Sarah).

Noemi’s classroom thus features a discourse that is generative (Brown, 2001) rather than reproductive, with the goal (ideational function) of developing consensus around understanding a mathematical concept (“Well, it was about what Catherine said…” – Sam). On the other hand many of the TIMSS 1999 video classrooms featured reproductive discourse, with the apparent goal of students being to guess what was in the teacher’s mind.

The tenor of the discourse suggests the interpersonal function of language. In Noemi’s classroom Carly uses the personal pronoun “you” in an inclusive sense (“it’s what you think will best show...”), rather than the exclusive sense commonly found in mathematics texts, thus giving agency to other students. She also uses the phrase “what I found was…”, indicating a high degree of personal ownership of the...
mathematics she was investigating. Noemi’s classroom is marked by a high level of mutual support (“Go, Carly”, and frequent applause). Students frequently self-correct (“I think what I was explaining…”) – Catherine), in contrast to more traditional classrooms in which correction is carried out by the teacher. Noemi’s classroom thus features a discourse in which students are empowered and emancipated mathematically, with relatively equal power relationships and knowledge being co-constructed.

The mode of the discourse refers to the certainty of the conclusions and the way in which cohesion is achieved (the textual function of language). In Noemi’s classroom there is a clear flow in the discourse, with students building on what others have said. It has a predominance of given/new structures, a feature of mathematical argument (“I think that what Catherine said makes sense, but I think…”). Students talk at length, rather than giving short answers as reported in the analysis of the TIMSS videos, in which the average student response length was fewer than five words (Hollingsworth et al., 2003). Student discourse in Noemi’s classroom is punctuated by “um” and ill-constructed sentences. Mathematical language is often vague or ill-defined, and symbols are used imprecisely (“if it was at 1 it would be at three”, rather than “if \( y = 3x \), then when \( x =1 \), \( y \) will be 3” – Campbelle). However in watching the video it is clear that the other students understand what is being said as it is accompanied by diagrams on the whiteboard. In contrast to many classrooms, the teacher does not intervene to correct language, nor to clarify what students say. The tentative nature of the language and concepts is valued (“On with my crazy scheme…” – Sarah), rather than mathematics being seen as something that is clearly defined and absolute.

Thus Noemi’s classroom allows students to see mathematical knowledge as both personal and social, rather than mathematics as something impersonal waiting to be uncovered. Cohesion in Noemi’s classroom is achieved through private and public reflection (“I was just thinking…” – Sarah) rather than through the apparently objective structure of mathematics as revealed by the teacher or text. In Noemi’s classroom the ‘dance of agency’ (Boaler, 2003), in which agency moves between students and the agency of the discipline, is evident.

**Discourse as discursive practice**

In Noemi’s classroom the texts (conversations) are initiated by the students, re-expressed and reformulated by other students, and distributed publicly as students come to the whiteboard. The texts are then consumed by the class, and the cycle of production, transformation, distribution and consumption is repeated. In contrast the conversations in many traditional classrooms, such as in the TIMSS 1999 video study, are controlled by the teacher, the students responding in ways which they hope will be acceptable to the teacher, with each interchange being self-contained, initiated and concluded by the teacher. The ‘force’ of the discourse in Noemi’s classroom is thus the social goal of including the entire class in the development of a shared understanding of the mathematical concept of gradient.
Although a preliminary reading of the transcript of Noemi’s classroom, in the absence of the video with the accompanying whiteboard diagrams, may appear to lack coherence, in reality students in the class are able to construct a coherent and meaningful interpretation of what others were saying. Students are able to make sense of and build on what others say (“a lot of what Campbelle said was actually correct…” – Catherine), and the producer of each discourse event expects other students to understand (“it’s really up to you and what you think will best show the lines on the graph…” – Carly). In more traditional classrooms coherence is produced by the teacher, by asking leading and prompting questions of students.

Noemi’s class has manifest internal intertextuality in that each piece of discourse is related to a previous one. There is some evidence of students using conventional structures of mathematical argument, particularly as they strive to produce a generalisation of how changing the value of \( a \) affects the slope of the line. While they start by looking at specific examples, they attempt to generalise (“like can we represent the numbers on the \( y \) and \( x \) axis with something else?” – Sarah). At the conclusion of the transcript, Sarah shows a graph on the whiteboard in which the \( x \) axis increases in intervals of 1, while the \( y \) axis increases in intervals of \( a \). She concludes that in this case every line will make a 45° angle with the axes. The text in Noemi’s classroom illustrates a social practice which requires students to make their thoughts publicly available and to use the ideas of others to jointly build an understanding of a mathematical concept.

**Discourse as social practice**

There is a marked contrast in the turn-taking practices and ratio of teacher to student talk between Noemi’s classroom and the more typical pattern of Teacher – Student – Teacher observed in many of the TIMSS 1999 video lessons, in which the ratio of teacher to student talk was of the order of 8:1 (Hollingsworth et al., 2003). Noemi’s classroom is characterised by a high level of equality between students and between the teacher and students. Power is located with students, and willingly given by the class to each student who is speaking (“Go Carly”). To a lesser extent students ascribe power to the argument produced by each student as they attempt to understand and build on each utterance. This is in contrast to more traditional classrooms in which students almost universally agree with what the teacher says.

In Noemi’s classroom students see themselves as active participants in learning, who have power over both the mathematics and the discursive practices of the classroom. Students in many other classrooms willingly accept a more passive role, in which the mathematics being learnt has power over them, and in which the teacher maintains control of the discursive practice of the classroom. The hegemony of such classrooms is maintained through an unspoken alliance between teacher and students, in which the students become passive partners in maintaining a classroom where agency resides with the teacher.
CONCLUSIONS

Critical discourse analysis has been used to analyse the conversation patterns and content in a year 8 mathematics classroom. In Noemi’s words:

“My aim in my Mathematics classroom is for students to regard Mathematics as an art which belongs to them, a means of regarding and interpreting the world, a tool for manipulating their understandings, and a language with which they can share their understandings. My students’ aim is to have fun and to feel in control.

“At the start of each year group responsibilities are established by class discussion and generally include rules such as every member is responsible for the actions of the other members of their group (this includes all being rewarded when one makes a significant contribution to the class and all sharing the same sanction when one misbehaves), members are responsible for ensuring everyone in their group understands what is going on at all times and students have some say in the make up of their groups.

“My role is primarily that of observer, recorder, instigator of activities, occasional prompter and resource for students to access. Most importantly, I provide the stimulus for learning what students need, while most of the direct teaching is done by the students themselves, generally through open discussion. Less obvious to the casual observer is my role of ensuring that students have the opportunities to learn all that they need to achieve required outcomes. It is crucial that I, as their teacher, let go of control of the class and allow students to make mistakes and then correct them themselves. An essential criteria for defining one of my lessons as successful is that I do less than 10% of the talking in the whole lesson.”

Noemi’s classroom exemplifies many of the conditions for learning through dialogue described, for example by Alrø and Skovsmose (2002). The discourse is exploratory, tentative and invitational, contains emergent and unanticipated sequences, is immediate, recognises alternative ideas even those that are strange (using shapes instead of numbers in an equation), and has a collaborative orientation in which students are vulnerable yet maintain high levels of mutual obligation.

In this way her classroom can be considered to be both empowering and emancipatory for students (Freire, 1972).

References


Appendix 1: Transcript of Noemi’s classroom

**Class**

**Carly**

Um, I think that what Catherine said makes sense but I think that when it comes to the values that you go up by on the graph it’s really up to you and it’s what you think will best show the lines on the graph. But what I found with ‘a’ is that the higher the value of ‘a’ the more acute the angle will be compared to the y-axis. So say, um, it was 4x then it will be closer to the y-axis than 2x. ‘Cause 2x will be here and 4x will be here. I found that the lower the value the closer it was to the x-axis. But the higher the value the closer it was to the y-axis. (Applause and a ‘whoo’)

**Sarah**

Just a question. I was wondering do you even need the, um … the numbers. ‘Cause where it says 5a don’t, can’t you just go like 7a + 2 or something. Like can we represent the numbers on the y and x axis with something else?

**Class**

Laughter, murmurs.

**Cameron**

Like shapes? (Laughter) So you could like do like squares, circles, triangles…

**Sarah**

Yeah but this is just more easy. (Inaudible)

**Teacher**

One at a time please. Could we just have one at a time? Kate, what did you just say?

**Kate**

I was saying that if you replace the numbers with like shapes and letters and stuff it’s just a complicating thing ‘cause we all know the number system and it’s simpler for us than all these other symbols.

**Sarah**

Yeah, but what I’m saying is, like, if, why we’re using the number system we’re really, um, pinpointing the graph ‘cause then we’re saying … one,
one and $y$ one, sorry, and we’re just you know we’re really pinpointing, I mean using numbers and if we like if we can find a way to represent it with letters then we’d be able to make it whole infinity, infinity instead of just drawing on the graph. Does that make sense?

Class *Muttering, faint “No”*

Teacher That might be something for people to have a think about. Sam, you had a comment before Sarah … talked about this stuff.

Sam* Well, it was about what Catherine said about having the … axis and the lines, the scale was being affected by ‘a’. What I you know thought was that ‘a’ doesn’t just affect the $y$-axis but it affects the $x$-axis as well. I mean that if you’re making a graph you want to put the, make the line cover the largest amount of distance possible. For example, that would look a lot better than having a graph that looked like that. ‘Cause it’s a lot easier to read. See? If, if, if - a good way to be able to get a graph, a graph looking like this *(points to one graph)* or like this *(points to another graph)* depending on whether $a$ is negative or positive would be good. So that’s where the scale comes in. *(Edited) (Applause)*

Campbelle Um, I found that with those ones that it’s kind of saying that for every one $x$ there’s going to be 3 $y$. So, with … if it’s one, two three - if it was at 1 it would be at three, if it was that because that for every 1 $x$ there is 3 $y$. If it was at 2 it would be at 6 and so on. So it’s, yeah, like that and with that one for every 1 $x$ there’s 4 $y$. *(Applause)*

Teacher Catherine?

Catherine I think what I was explaining what I was doing before as $3x$, I think I was mixing up the scale, um, a lot Campbelle was saying is also actually correct. If it was 1 it would be 3, so if $y = 415x$, then, well $x = 1$ then up here and 415. If you’re going… I don’t know what you’d go up by but it would be like, um, that so it would go up there and that here it would go there so like right straight like that. *(Edited) (Applause)*

Oakley *(edited)*

Teacher Any other comments? *(Waits)* I was going to give you something else to think about.

Sarah On with my crazy scheme to play, to change the numbers… Crazy scheme is cool. Um, I just thought of this ‘cause I was just thinking you know how I could do it…and you know how it says up here 3 plus you know how she said up by 3 so then the y-axis would go up by 3…back to the $y = ax$ that means….*(camera cuts out).*

*This child has a stutter.*