Language in the Mathematics Classroom

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Mathematics is a central part of school curricula around the world. There has been much interest in linguistic aspects of the teaching and learning of mathematics, both from mathematics educators and from applied linguists. This short paper introduces a set of five articles exploring the intersection between these two communities. The articles all discuss two texts: an extract from the guidance issued to primary school mathematics teachers in the UK; and an extract from a primary school mathematics lesson. This paper begins by summarising some of the research on language in the mathematics classroom, before introducing the two texts.

Keywords: mathematics education, classroom discourse, primary school education, educational policy

There is a long tradition in applied linguistics of research into linguistic aspects of classroom interaction, both spoken and written. Mathematics is almost universally a core part of curricula around the world. There is considerable interest in language-related issues in the mathematics education community (for an extended discussion, see Pimm, 1987). Research foci have included mathematics classroom discourse (Brown, 1997; Rowland, 2000; Steinbring *et al.*, 1998), multilingual mathematics classrooms (e.g. Adler, 2001) and genres of written school mathematics (Morgan, 1998). The topic has received less coverage in the applied linguistics community. Interest among linguists dates back to Halliday's (1978) discussion of the mathematics register, and has focused on topics such as the role of narrative in mathematics (Solomon & O'Neill, 1998), the language of mathematics in aboriginal Australian languages (Watson, 1988) and more recently, issues arising in the context of bilingual education (de Courcy & Burston, 2000; Monaghan, 1999).

The researchers cited above have drawn on a range of theoretical perspectives, including systemic functional linguistics (e.g. Morgan, 1998), linguistic anthropology (Watson, 1988), post-structuralism (Brown, 1997) and socio-cultural theory (studies in Adler, 2001; Steinbring *et al.*, 1998). In general, research conducted within mathematics education has been concerned with the teaching and learning of *mathematics*, drawing on ideas from linguistics as theoretical and methodological tools in this endeavour. Research in linguistics, on the other hand, where it has focused on mathematics classrooms, has been interested in the *linguistic* aspects of the teaching and learning of mathematics, such as the nature and acquisition of the mathematics register. There has been little attempt to bring research from the two communities together, in order to relate, for example, issues of the acquisition of the mathematical register with the acquisition of mathematical concepts. The papers in this collection emerge from this intersection between the two academic communities.

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Contexts

The purpose of the papers that follow is to consider issues relating to the nature of mathematics classroom interaction, drawing on ideas from applied linguistics and mathematics education. These two communities are each represented by two authors. Constant Leung and Brian Street carry the flag for applied linguistics, whilst Candia Morgan and I wear the colours of mathematics education, although, as is evident from the papers each has contributed, the boundaries are not as clearly demarcated as I have implied.

In the papers that follow, the authors take as their starting point two texts, one taken from documentation issued to teachers in the UK, the other an extract from a transcript of a Year 5 (ages 9–10) mathematics lesson. It will be helpful at this stage to provide some background information on the two texts, both of which are located within the UK's National Numeracy Strategy (NNS) (DfEE, 1999). I will, therefore, give a brief outline of the NNS, followed by more specific information about each of the two texts.

The National Numeracy Strategy

The National Numeracy Strategy was introduced by the UK Government's then Department for Education and Employment (DfEE) in 1999. It is widely, though not universally, used by primary schools in England and Wales. The strategy provides a 'framework' for mathematics teaching in all primary school year-groups and is presented in one large ring-bound document (DfEE, 1999), plus a number of supplementary booklets. The framework operates at several different levels:

- At the level of *a school year*, the NNS offers a week-by-week plan designed to cover all areas of the mathematics curriculum for that year-group (DfEE, 1999, Section 3). This plan includes 'spare' weeks to allow for some flexibility. These spare weeks can be used for revision, for example. Like all aspects of the NNS, the year plan is advisory.
- At the level of *content*, the NNS provides a detailed summary of the mathematics to be covered in each topic, as well as a comprehensive set of example questions and problems (DfEE, 1999, Sections 5–6).
- At the level of *each day's work*, the NNS sets out a recommended format for a typical lesson (DfEE, 1999, Section 1: 11–16). The format suggests that each lesson should be made up of three parts. The first part consists of 10 minutes of 'warm-up' activities, particularly focused on mental arithmetic. The second part, forming the main body of the lesson, begins with an introduction to the topic for the day by the teacher working with the whole class. The class then works in smaller groups, with the teacher working intensively with one group each day. The final part of the lesson consists of a plenary discussion led by the teacher, in which aspects of the group work might be discussed and taken forward.

The two texts to be referred to in this collection of papers are each located within the context of the NNS.

Text 1: Extract from *Mathematical Vocabulary*

Mathematical Vocabulary (DfES, 2000) is a 36-page A4 booklet, supplementary to the main NNS document. It largely consists of lists of mathematics vocabulary items, given by year-group. Thus there are lists for Year 1 (5–6 years) to Year 6 (10–11 years). The booklet begins, however, with five pages of guidance for teachers on the introduction and use of mathematical language in mathematics lessons. Text 1 (see Appendix 1) is an extract from this guidance.

Text 2: Extract from a transcript of a Year 5 mathematics lesson

As part of recent research, I recorded several mathematics lessons of a Year 5 class in a primary school in an urban part of England. The extract (see Appendix 2) comes from a transcript of a lesson in which the class worked on two dimensional shapes (e.g. square, circle, triangle) and three dimensional shapes (cuboid, cylinder, prism). Many members of the class have encountered these ideas in previous years. The extract comes from the start of the lesson, in which the teacher is roughly implementing the first 'warm-up' section outlined in the NNS. She gives an objective for the 'warm-up': 'to be able to describe two dimensional shapes' (turn 1). In the ensuing discussion, the concept of 'dimension' itself becomes the focus. The discussion portrayed in this extract (in which I participate) stood out for me at the time, since in mathematical terms, although brief, the ideas are rich and go beyond the confines of the NNS, or of what might be expected for students of this age.

In the papers that follow, the authors consider the contrasts and tensions between the two texts to explore the relationship between language and mathematics. Each author draws on their research interests to take a distinct focus. Candia Morgan explores the role of definitions in both written and spoken mathematics classroom interaction. My own contribution considers the issue of ambiguity in the mathematics classroom, a place where ambiguity might be expected to have no place. Constant Leung addresses issues concerning mathematical vocabulary. Brian Street draws on the idea of academic literacies to explore some of the 'hidden knowledge' displayed by the participants in the lesson transcript, before considering some possible implications for pedagogy. In a final paper, the four of us reflect together on the connections between our contributions, as well as on what these different various perspectives make it possible to see and on the relationship between applied linguistics and mathematics education. As we show, this relationship is more complex than a simple link between words and numbers.

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Appendix 1: Extract from *Mathematical Vocabulary* (DfEE, 2000: 2)

How do children develop their understanding of mathematical vocabulary?

> Teachers often use informal, everyday language in mathematics lessons before or alongside technical mathematical vocabulary. Although this can help children grasp the meaning of different words and phrases, you will find that a structured approach to the teaching and learning of vocabulary is essential if children are to . . . begin using the correct mathematical terminology . . .
>
> Some children may start school with a good understanding of mathematical words when used informally, either in English or their home language. Find out the extent of their mathematical vocabulary and the depth of their understanding, and build on this.
>
> You need to plan the introduction of new words in a suitable context, for example, with relevant real objects, mathematical apparatus, pictures and / or diagrams. Explain their meanings carefully and rehearse them several times . . . Encourage their use . . . through your questioning. You can help sort out any ambiguities or misconceptions . . .
>
> The final stages are learning to read and write new mathematical vocabulary in a range of circumstances, ultimately spelling the relevant words correctly.

Appendix 2: Extract from a Year 5 Lesson Transcript

T = the teacher. **RB** = Richard Barwell. Students are indicated by letters, e.g. **W** or **?** where it is not clear who is speaking. Bold type indicates emphasis. [are used for overlaps.

1	**T:**	Right the learning objective for our mental and oral starter is to be able to **describe** two dimensional shapes. (*Writes on board*)
2		Can anyone remind us what a two dimensional shape is (*Lot of noise outside classroom*)
3		B can you shut the door please. W.
4	**W:**	(. . .)
5	**T:**	(you can describe it as) **flat** okay good flat's a good way for you to describe two dimensional shapes. D.
6	**D:**	(It hasn't) got breadth, width and length.
7	**T:**	It's got breadth and length it's got **width** and it's got length yep correct and it's got length. Anything else about two dimensional shapes got. What's the difference then between two dimensional and three dimensional. W tells us it's **flat** that's fine. Are there anything else to say. F.
8	**F:**	Um a (three dimensional shape) has breadth, length and height.
9	**T:**	Well done. This would be a two dimensional shape (*draws a square*) (. . .) and a three dimensional shape will have an extra dimension. That would be a **solid** shape (*draws a cube*) okay G.
10		Can you open the window please F and V could you open the window please.
11	**H to T:**	(. . .)
12	**T to RB:**	(do you know what) a one dimensional shape (is)?
13	**RB:**	A one dimensional shape
14	**V:**	I know what a one dimensional [shape is
15	**RB:**	[go on
16	**V:**	A line
17	**RB:**	(. . .) so what's a no- a zero dimensional shape
18	**?**	Nothing
19	**?**	A dot
20	**B:**	Yeah. It's got no length, no width, no height
21	**F:**	But a dot but a dot but a dot might end up as a circle
22	**A:**	Yeah coz a little tiny circle (*gestures a circle with a finger*) (. . .)
23	**F:**	(. . .)
24	**RB:**	So how many dimensions has a circle got
25	**F:**	None (*shrugs*)
26	**T:**	(*draws circle*) None? One?
27	**?**	One
28		(*Many voices*)
29	**G:**	(*Gestures a circle*)
30	**T:**	What's this bit called (*drawing round circle again*)
31	**Several:**	Radius
32	**T:**	Circumference. It's got a circumference. It's got a diameter (*draws*

E–W diameter) it's got a radius (*draws NE radius*). What d'you think Z?

33 **Z?** Two dimensional
34 **T:** Two dimensional?
35 **?** Yeah
36 **V:** And a sphere is three dimensional
37 **T:** And a sphere is three dimensional. What would be a one dimensional circle then
38 **A:** (. . .) a line (*shrugs*)
39 **T:** Just a diameter (*points to diameter from before*). Yes J
40 **J:** (m a two dimensional is flatter . . .)
41 **T:** Yep flat. Look. (*picks up a plastic circle from a set*) I don't like these (. . .) coz they look like three dimensional don't they. They're thick but they're not meant to be, they're meant to be two dimensional. Okay, they're flat shapes (*picks up a square*)
42 **?** A cylinder
43 **T:** Yeah that's a cylinder (*laughs, waves circle*) (and that's a)
44 **?** a cuboid
45 **T:** cuboid (*waves square*). But it's not meant to be it's meant to be flat. Yes K.
46 **K:** There's no such thing as a one dimensional shape coz a line is kind of like a rectangle filled in
47 **T:** Yeah. What just a line? (*points to board*)
48 **K:** Yeah
49 **T:** Like a – what like [(. . .) (*gestures thinness*)
50 **K:** [a rectangle filled in
51 **T:** (*Giggles*) Very clever. Like a dot (*draws dot*) oops (*erases, does again*) like that. It's interesting isn't it. Yes H?
52 **H:** (. . .) sometimes things made out of paper's um um two dimensional
53 **T:** Yeah
54 **H:** (. . .) has just a tiny tiny **tiny** (*gestures thinness*)
55 **?** Very thin
56 **T:** So you've got to draw it on paper so it's going to have certain thickness (*gestures thinness*). Anyway . . . (*changes subject to next part of lesson*).