Language in Use in Mathematics Classrooms: Developing Approaches to a Research Domain

H.Steinbring, M.G.Bartolini Bussi and A.Sierpinska, *Language and Communication in the Mathematics Classroom*, Reston, VA: National Council of Teachers of Mathematics, 351 pp., 1998, ISBN 0-87353-441-7

Language and Communication in the Mathematics Classroom is a collection developed from papers presented in the working group on Language and Communication that met at the Sixth International Congress of Mathematics Education (ICME) in Quebec in 1992. In spite of its broad title, it is not (and does not claim to be) comprehensive in its coverage of the field. Indeed, there are some notable gaps – current areas of research and curriculum development interest that are not addressed. In particular, issues of bilingualism are completely missing (see, for example, Cocking & Mestre, 1988; Ellerton & Clements, 1991) and the growing interest in 'Writing to Learn Mathematics' (see, for example, Connolly & Vilardi, 1989) is barely represented. Nevertheless, there is much that is of interest, ranging from theoretical discussion of the nature of classroom communication to detailed accounts and interpretations of mathematical interactions and analyses of transcripts of teacher and student talk. It is primarily a collection of reports of research but holds much that may be of interest to teachers and teacher educators as well as researchers.

In 1979, a review of research on language in mathematics education by Austin and Howson depicted a field in which there were many gaps and questions. Twenty years on, the papers collected in *Language and Communication in the Mathematics Classroom* also raise more questions than they answer. The questions, however, are rather different ones. The authors surveyed by Austin and Howson largely conceived of the 'language of mathematics' as a clearly recognisable entity, predominately identified with the written symbolism and specialist vocabulary of formal mathematical writing. The major questions focused on how students come to learn this language and the obstacles in their way. As within the German tradition of *Stoffdidaktik* described by Steinbring (chapter 5), it was assumed that 'in the end, the everyday language of the students is subordinate to the technical language' (p.103). In contrast, most of the authors represented in this collection are more interested in issues of discourse, communication and interaction in mathematics classrooms – language 'in use' – than in the formal characteristics of mathematically 'correct' language.

While the treatment of language and communication issues in mathematics education research has clearly developed and matured over the last twenty years, there is still wide diversity: in the research questions addressed; in the methodologies used; in the disciplines that are drawn upon; and, most fundamentally, in the ways in which relationships between language, mathematics and mathematics education are conceptualised. As I have already suggested, the simplistic identification of mathematical language with its formal symbolism and specialist vocabulary is no longer widely held. The associated conception of language as a straightforward conduit of meanings, with its concomitant deficit model of learners and focus on their difficulties and confusions in using this conduit, also appears less prevalent among researchers than it was at the time of Austin and Howson's review. While Pirie (chapter 1) identifies and addresses the "gulf between thought and symbol", her introduction of the notion of "quasi-mathematical language" – unconventional or invented language used by learners in mathematically significant ways – indicates the fuzziness of the definition of mathematical language and begins to recognise the difficulties involved in a dualistic conception of thought and symbol/language. As Sierpinska (chapter 2) points out, "the relation between the ordinary language and mathematical thought is much more subtle than once believed" (p. 41).

There is now a clear mainstream consensus that language plays an important role in teaching and learning, and, in particular, that discussion is a useful medium for developing learning. This may be seen in current curriculum developments encouraging richer forms of communication in the mathematics classroom, including active student use of language (see, for example, NCTM, 1989). It may also be seen in the burgeoning of interest in research related to classroom communication and use of language, represented in part by the chapters in this book. There is, however, less clarity about the ways in which language works and, specifically, about the role that interpersonal communication plays in the teaching and learning process. Sierpinska's chapter, which serves as an introduction to the rest of the book, provides a useful review and analysis of three epistemological perspectives on language and communication: constructivist, arising from Piagetian views of language; sociocultural, based on the work of Vygotsky; and interactionist. The latter covers a broad range of views on learning and philosophy of language, characterised by a focus on classroom discourse rather than individual cognition. All three perspectives reject the idea that communication can be seen as transmission of knowledge. This rejection of a transmission view of communication is common to all the chapters in the book. The second section continues to

develop discussion of theoretical perspectives on language and communication, in particular considering approaches to studying classroom discourse, drawing additionally on ethnography (Seeger, chapter 4) and Wittgenstein's philosophy of language (Kanes, chapter 6). No unified theory emerges from these chapters but we do find strong recognition that studying language and communication in mathematics classrooms needs to be based on sound theoretical ground.

The variety of theoretical influences represented in the early sections of the book is paralleled by the variety of kinds of classroom and approaches to studying classroom interactions to be found in the later sections. Part 3, entitled 'Different Styles and Patterns of Communication in the Mathematics Classroom' contains a number of analyses of interactions between teacher and students and between students in small group settings. A striking feature of these chapters is the richness of the data the reader is presented with in the form of transcripts and descriptions of classrooms. We are impelled to see the enormous variation that is possible in patterns of interaction within classrooms, associated with differences in implicit cultural expectations as well as with teachers' and researchers' explicit beliefs and decision making.

A recurrent theme is the examination and questioning of the teacher's role; to what extent does the teacher control the interaction and the structuring of knowledge for the students? There appears to be a dominant belief, associated with reform movements that have drawn simplistic teaching implications from constructivist theories of learning, that too much teacher control is 'a bad thing'. The analyses of data presented in several chapters seek to support this belief. For example, Abele (chapter 7) presents two case studies contrasting a teacher-led discussion with a student group discussion of the same mathematical problem. It is tempting to agree that the discussion without teacher intervention resulted in 'better understanding', though we have to ask whether the results were equally 'better' for all the students involved. The students certainly had greater opportunities to be active participants in a mathematical discourse. But how are we to know what the students understand? How do we make inferences about people's mathematical understanding from the things they say? There has been too little theoretical discussion of the basis of such inferences (see Morgan, 1996). As Wood argues (chapter 9), different patterns of classroom interaction provide different kinds of learning opportunities. But I would suggest that what we can actually observe as the outcomes of these different patterns is not better or lesser 'understanding' but different sets of behavioural norms, social expectations and values. As students adopt the 'formats of argumentation' accepted within the particular mathematics classroom

(Krummheuer, chapter 13), the meanings they appear to express will 'converge to a pedagogically intended mathematical definition of the situation' (p.228). Judgements about 'better understanding', however, are made from the values of the particular discursive position adopted by the teacher or researcher and reveal only the extent to which student behaviours match those values.

The shift towards interest in patterns of interaction and language use in classrooms rather than formal characteristics of mathematical language sometimes appears to have lost sight of the mathematics. If we are concerned with language and communication in the *mathematics* classroom, however, it is still important to consider what is characteristically *mathematical* about the language and the ways in which it is used. It is difficult to see in many of the chapters how communication in mathematics education is distinct from communication in other subject areas other than in the apparently incidental topics being discussed in the classroom. But abandoning transmission views of communication must be associated with a recognition that mathematical knowledge is not simply the 'content' of the classroom interaction but is constituted by it. Communication in 'Specific Domains of Mathematics' is taken up in the fourth and final section of the book.

The 'gap' between natural language and mathematical symbolism has traditionally been highlighted in discussions of the nature of mathematical discourse, and students' use of algebraic notation (or, more commonly, their failure to use it correctly) has been the subject of much research. The suggestion that using natural language can serve to help students to develop the use of algebraic notation is not new (see, for example, James & Mason, 1982) but, in practice, has tended to conceptualise the move towards algebra as a process of translation from one symbolic system to another. Arzarello (chapter 15), however, postulates a rather different role for natural language in the development of algebraic problem solving. In an interesting, in depth discussion, he locates at least some of the difficulties experienced by students in the epistemological, psychological and linguistic differences between arithmetic and algebraic activity and suggests that a 'syncopate' style of operating symbolically while sustaining the associated reasoning in natural language can help students to develop meaning for the algebraic manipulation and to break with arithmetic thinking. Arzarello claims that in classes where students are encouraged to use this style, students of 'average verbal ability' are successful at algebraic problem solving, while in control classes only those 'with high verbal performance' are successful (p. 257). Unfortunately, he does not elaborate the characteristics of the natural language used.

Written mathematics is multi-modal in the sense that it makes use of several symbolic systems within the same text. It is, perhaps, to be expected that, when the specifically mathematical features of that text are considered, attention is focused primarily on the symbolic systems that are generally absent from non-mathematical texts. Thus it is not surprising to find chapters focusing on algebraic (Arzarello, chapter 15; MacGregor, chapter 16) and graphical (Kaldrimidou & Ikonomou, chapter 17) systems. The use of the verbal mode (or 'natural' language) is generally represented as a system with which students already have facility and which serves as a background against which the other, strictly 'mathematical', systems are interpreted. What tend to be neglected are those aspects of the verbal mode that are characteristically mathematical, including the characteristics of oral mathematical discourse. Given the amount of interest among mathematics educators in mathematical proof it is perhaps surprising that so little attention has been given to linguistic aspects of mathematical reasoning in 'natural' language. Navarra (chapter 19) recognises the importance of linguistic skills in understanding and constructing logical arguments, but the contexts within which his students are arguing, though involving a logic compatible with mathematical logic, are not mathematical. Although there may be similarities, argument in mathematics is not identical to argument in non-mathematical contexts.

The focus on 'language in use' in mathematics classrooms that characterises the approaches taken by the contributors to this book represents an important development in the study of language in mathematics education. There is, however, a tendency to look at examples of 'language in use' as dependent solely on their current social setting (e.g. teacher dominated, peer group debate, etc.) without considering their histories or futures. How did the participants come to be able to speak or write in these particular ways? Do the resources they are drawing on arise from experiences in the mathematics classroom or from elsewhere? How may the 'language in use' in a particular classroom or by a particular student develop – become more 'mathematical'? While these questions are touched on (notably by Krummheuer, chapter 13), there is still much work to do in relation to how students may learn to use language mathematically and what role teachers may play in this.

There are clearly a number of alternative perspectives on the nature of communication in mathematics classrooms and the discussion of these perspectives in this book serve as a basis for further theoretical development and a useful resource to help researchers to clarify the issues involved. When it comes to the examples of analysis and discussion of classroom discourse, the frameworks used for the analysis and the bases for evaluation and consequent

pedagogic recommendations are sometimes less clear, in some cases apparently resting more on reformist idealism than on criteria related to mathematical learning or evidence arising from the research data. This may be the consequence of an apparently strict word limit on the chapters, which in some cases has resulted in a somewhat unsatisfactory brief outline of theory with snippets of analysis and discussion of empirical results. Though the editors have done a good job of structuring the book as a whole and highlighting some of the major issues, I still get the impression that many of the authors are talking past each other, pursuing their individual lines of thought rather than coming together to build a coherent research domain. The chapters, nevertheless, provide much food for thought and, by including extensive transcripts of classroom interactions, allow their readers to engage in constructive critique and to test out alternative interpretations. As is the nature of collections arising from conferences, there is unevenness and, as I have already said, some lack of overall coherence. The quality of the contributions is, however, generally high and I am sure that any reader with an interest in the topic will find something in this book to reflect on and to extend their thinking about language and communication in mathematics classrooms.

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