

## INTRODUCTION

A demanding, prudent, “experimental” attitude is necessary; at every moment, step by step, one must confront what one is thinking and saying with what one is doing, with what one is. (Foucault, 1984, p. 374)

As teachers, we rightly value the ways in which our students bring meaning to the mathematical situations they encounter. There is much scope for judgment, insight and creativity in the style of mathematical work being introduced in many schools and we may aspire to encourage these qualities in the students’ learning. Yet there is still a need for an individual to reconcile her own personal mathematical understanding with the ideas and traditions which have grown out of centuries of mathematical exploration and invention (cf. Ball, 1993). Whilst students can be creative mathematicians there is still a need to be able to do everyday calculations and understand aspects of conventional mathematical thinking. We are often torn between attempting to focus on our students’ own way of seeing their mathematical endeavours, and seeing these endeavours with our own eyes, inspired perhaps by a “correct” view of mathematics. There are inevitably difficulties for us in making sense of students’ own developing understanding without using our own “expert” overview as a yardstick, especially when we pose the tasks that they are working on. Teacher descriptions of students’ learning often presuppose an adult overlay framing the mathematical ideas supposedly being addressed. Meanwhile, the sort of constructions which students are likely to generate for themselves are a function of their own particular concerns in relation to the sorts of tasks with which they are presented. Whilst we may wish to encourage students to pursue their own mathematical concerns at times, we retain the option of blowing the whistle and denying that their work is indeed mathematics in the sense that we as teachers intend. Furthermore, as the apparent relevances of different aspects of mathematics, as perceived by society, grow or decline, the nature of tasks on offer, and the values associated with them, will alter.

In the climate of rapidly accelerating social change that we now face, conventions get replaced with alarming regularity and, as teachers, we face challenge in any supposed role as experts in the worlds our students will encounter. In meeting this we need to continually reassess how our intentions might be concealing yet promoting initiation into existing structures which in turn support the reproduction of those structures. Our ways of describing the

world need to constantly readjust to meet new demands. At the heart of this is a readjustment in the relationship between the rate at which we grow and the pace at which our environment changes; the very relationships between adult-child, teacher-student, mother-daughter are brought into question, as are the ways these relationships underpin assumptions about approaches to teaching. When social change was slow it was reasonable to suppose that what was good for the father was good enough for the son. As it speeds up, however, conflicts arise; the weakening of the family being but one example. Brookes (1994, p. 45) suggests that for education systems to be compatible with the world as we experience it we need to

accept the twin constraints of an environmental framework that is changing non-repetitively and accelerating and a generational framework which is cyclically repeatable and only gently changing.

This entails an on-going renegotiation of social roles and reevaluation of how we construct and utilise knowledge. The task of education becomes ever more concerned with enabling us to understand the changes of which we are part and to see how we might have some influence over them.

In academia at large it is no coincidence that the study of language has become so prominent in our examination of the social world; the world does not rest for long enough to allow descriptions of it to settle and become familiar. We become immersed in multiple "feedback" as our attempts to describe things grapple with a world entangled in its own self descriptions. As mathematicians we have often sought immunity to these shifts. The apparent sturdiness of mathematics has somehow resisted pressure to be more responsive to changes in demands made upon it and mathematical activity has retained an image of being anchored by various mathematical truths. But it is now becoming more apparent that mathematics is created and utilised through history according to time dependent needs which change ever faster. Mathematics education research has responded by promoting less "positivistic" understandings of its host discipline, but as yet has seemed reluctant to go the whole way to understanding itself as an integral part of a social web subject to fundamental and continuous reevaluation. As such one might argue that we have not fully addressed the "strong programme" presented by Bloor (1976), which sought an extension of the practices of sociologists of scientific knowledge to include an

examination of the content and nature of human scientific knowledge, and not just the circumstances surrounding its production.

Broadly, this book concerns the way in which language and interpretation underpin the teaching and learning of mathematics. In tackling this theme I wish to position some issues arising from research in mathematics education in relation to some major writers in continental philosophy. In particular, issues of language, understanding, communication and social evolution, all of which are tackled by recent mathematics education research under the banner of constructivism and related areas, are central themes in post-war western thinking on philosophy and the social sciences, yet research in mathematics education seems to under-utilise the resource of work done in the broader context. Whilst there is a growing recognition that such work is of importance (for example, Walkerdine, 1988; Skovsmose, 1994), we are still in the early days of such developments. In developing my theoretical framework I will be calling on certain key writers such as: Gadamer and Ricoeur on hermeneutics, Habermas on critical social theory, Saussure on linguistics, Derrida, Foucault and Barthes in post-structuralism and Schütz on social phenomenology. I seek to show how language is instrumental in developing mathematical understanding and also how both chronological and spatial dimensions of classroom experience condition ideas being met. I examine how language functions in orienting action within the normative constraints of a given situation and suggest that the task of the learner could be seen as reconciling experience with both conventional and potential ways of describing it. Classroom examples offered show school students seeking to capture their understanding in symbolic form. Meanwhile, college examples show teacher education students capturing their understanding in reflective writing. Recognising that the perspective of participants is becoming more central within analyses of social situations, this book offers a theoretical approach to discussing the world as understood through the eyes of participants. Within mathematics education research this means attending to the way in which students and teachers experience the classroom situation which they are in. These perspectives, it is suggested, are imbued with culturally derived or institutionally imposed structures, present both in the words used by inhabitants and in the physical space they occupy.

Most of the examples offered will describe students in the age range six to twelve learning mathematics in schools, although there will be some discussion of work taking place within teacher

education courses including some detailed descriptions of approaches taken. I am writing as someone immersed in the British educational system and drawing on research published in English. Nevertheless, much of the empirical work was carried out in an English speaking Caribbean country (Dominica). The remaining school based material was collected in England from lessons observed in culturally diverse classrooms in London and Manchester, and some from my own classroom teaching in the Isle of Wight. The work reported with initial training students and practising teachers took place at Dominica Teachers College and the Manchester Metropolitan University. As such the majority of situations reported are connected to my own professional concerns as a teacher and teacher trainer. These situations are not typical of classrooms in general; rather my observations were motivated by an intention to locate and analyse examples of students expressing their understandings verbally or in writing. In a sense I am identifying what I see as examples good practice based around a struggle by students to combine mathematical activity with reflection on it. It is hoped that these examples be interpreted as possible strategies for developing the linguistic dimension of mathematical activity in line with a major theme of this book which sees this broadening of mathematical concerns as an approach to situating mathematics in a more developed notion of society.

*Chapter one* presents an exposition of hermeneutics together with an outline of its roots in phenomenology. It emphasises language as manifested in action rather than as a transcendently existing system. This provides a platform for a social scientific analysis of mathematical learning seen as interaction, linguistically mediated and governed by social norms, that seeks to reconcile evolving understanding with static forms.

*Chapter two* further examines how language functions in orienting mathematical thinking and acting, and offers practical examples of how this is achieved. After outlining how Saussurian linguistics provides the roots of post-structuralism, it employs this theoretical perspective in developing the notion of linguistic framings of mathematical ideas being more stable than the thinking generating them. Further, the self-reflexive qualities of language that position the individual in her society are examined as an important dimension within that individual's self formation. This is used in addressing the difficulty of distinguishing between the

individual learner creating and inheriting mathematical ideas.

*Chapter three* focuses on sharing mathematical perspectives and questions the potential which language displays in locating and holding on to mathematical ideas in doing this. For example, it examines the difficulties teachers face in alerting their pupils' attentions to mathematical ideas that the teachers seek to share. It also asks how students represent their understandings. A detailed description of a lesson is offered in which students seek to reconcile their mathematical experiences with various ways of capturing it for sharing with others. This commences a substantive analysis of children doing mathematics which spans the next four chapters.

*Chapter four* seeks to capture the classroom through a preliminary study of how students experience mathematics in their classroom environment. It is suggested that the physical and social dimensions of the classroom frame and so condition the mathematics being encountered. A number of examples are offered of students being guided by verbal instructions, peer interaction, physical apparatus, learnt rituals, and so on.

*Chapter five* introduces a more theoretical treatment of this classroom experience. Utilising a framework from social phenomenology, it examines how students orientate themselves within the space within which they see themselves working. Their learning is described as a hermeneutic reconciliation through time between their expectations and their actual experience; between this experience and their attempts to capture and share it.

*Chapter six* pursues the phenomenological approach in examining how the teacher maps out a picture of the individual student's understanding through the evidence available in the immediate classroom situation, with view to guiding and shaping the emerging mathematical thinking of the student.

*Chapter seven*, which comprises new material, examines a theoretical perspective on the ways in which children progress in learning mathematics. It suggests that there is a difficulty in associating teaching discourses with the mathematics they locate. This can result in an incommensurability between alternative perspectives being offered. The chapter resists attempts to privilege any particular account but rather demands an analysis of these discourses and their presuppositions. In developing these themes the chapter invokes Ricoeur's analysis of time and narrative as an analytical approach to treating notions such as transition, development and progression in mathematical learning.

*Chapter eight* argues for seeing all mathematical experience as being linguistic. Leaning primarily on the work of Derrida the

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