Natural communication in mathematics classrooms: What does it look like?

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This paper recounts how preparation of case study material for a multimedia resource raised questions about traditional power relations in the control of communication in mathematics classrooms. It aims to provoke discussion on whether more natural patterns of interaction should be promoted, who should shape communication channels, and the roles of researchers and teacher educators in transforming classroom interaction. Ethical issues related to forms of presentation of the data are raised.

Introduction

This paper intends to provoke further deliberation and debate about relationships between teachers' control of classroom interaction and the learning of mathematics. It arises from our involvement in a research and development project that focuses on the use of an interactive multimedia resource for mathematics teacher education (Sullivan & Mousley, 1994). Each CD-ROM disc in the program presents a case study, with a video of a whole mathematics lesson linked to interviews with the teacher, the lesson transcript and notes, readings pertaining to particular aspects of the pedagogical style and specific components of the teaching, graphic representations of the classroom interaction, and other features.

As we were developing the CD-ROM discs and their accompanying manuals, seeing the classroom interaction represented in a number of media raised some problematic issues about communication in mathematics classrooms. This paper focuses on just one issue—teachers' control of communication—and uses one case study from the resource to illustrate our reflections and discussions.

Communication

Effective communication was one of the six components of quality teaching identified in an earlier survey (Sullivan & Mousley, 1993) when we grouped phrases used by questionnaire respondents into what seemed like categories useful for describing good teaching. In reporting this stage of the project, we summarised the phrases about classroom communication as follows:

> Communication relates to opportunities for talking, explaining, describing, listening, asking, clarifying, sharing, writing, reporting, and recording. It includes class organisation structures such as co-operative groups, and is characterised by an orientation of teacher and students to accepting communication as a two-way process ... (It) is vital in organising for learning, engaging students, and nurturing their all-round development, as well as in mathematical problem-solving ... Most importantly, it is a key aspect of building understanding. (Sullivan & Mousley, 1994, pp. 428-9)

It was not surprising that communication surfaced as an important feature of quality teaching. Attention to language factors in mathematics education has long been recognised as a focus for the improvement of pedagogy (see, for instance, Del Campo & Clements, 1990; Mason & Pimm, 1986; Mousley & Marks, 1991; Pimm, 1987). In Australian mathematics education research, there seems to be a recent surge of interest in analysing and improving patterns of classroom interaction, as noted by Ellerton and Clarkson (1992):

> ... especially over the past four years, Australian mathematics educators have investigated ways and means of establishing mathematics learning environments in which learners interact with each other and with their teachers in ways which will improve the quality of mathematics learning. (p. 153)

Data Which Raised the Issue

The case we wish to draw on for this paper was filmed in a Year 6 class. The students were asked to make as many different 'box-shaped' buildings as possible using 24 blocks, to record and compare their solutions in groups, and then to report their findings orally. In handling the data collected in this classroom, there were three incidents that increased our awareness of the problematic nature of classroom communication patterns and of dilemmas that teachers face as they organise discussions and thus position themselves and students within the discursive field.

The first incident arose just after the lesson had be filmed and particular components of the high-quality teaching had been identified. Before the video was committed to CD-ROM disc, we were keen to validate the existence of each of the components. We asked colleagues to watch the videotape and write naturalistic summaries of what they observed. We noted that there was a distinct division in the way that people commented on teacher-to-student communication. Some people suggested that the teacher had focused much more on some pupils than others and should have been more inclusive. Others, however, commented on her nurturing manner of allowing students to join the dialogue when they felt they had something positive to contribute. (For discussion of these disparate positions, see Mousley and Sullivan, 1994).

The second surprising event occurred when, in preparing the multimedia resource, we transcribed the lesson's audio component, noted the numbers of verbal interactions each child contributed, then graphed these. Our intention here was to link electronically each bar of the graph to video snippets of that child's interactions, so that clicking the indicator on a bar would allow users to examine the interactions more closely, enabling a study of, for instance, features such as different types of questions used, the quality of particular comments of classroom participants, or the teacher's responses to individual students. Since the lesson had seemed inclusive of all children, the unevenness of the interactions in the graph produced (Figure 1) was not foreseen.

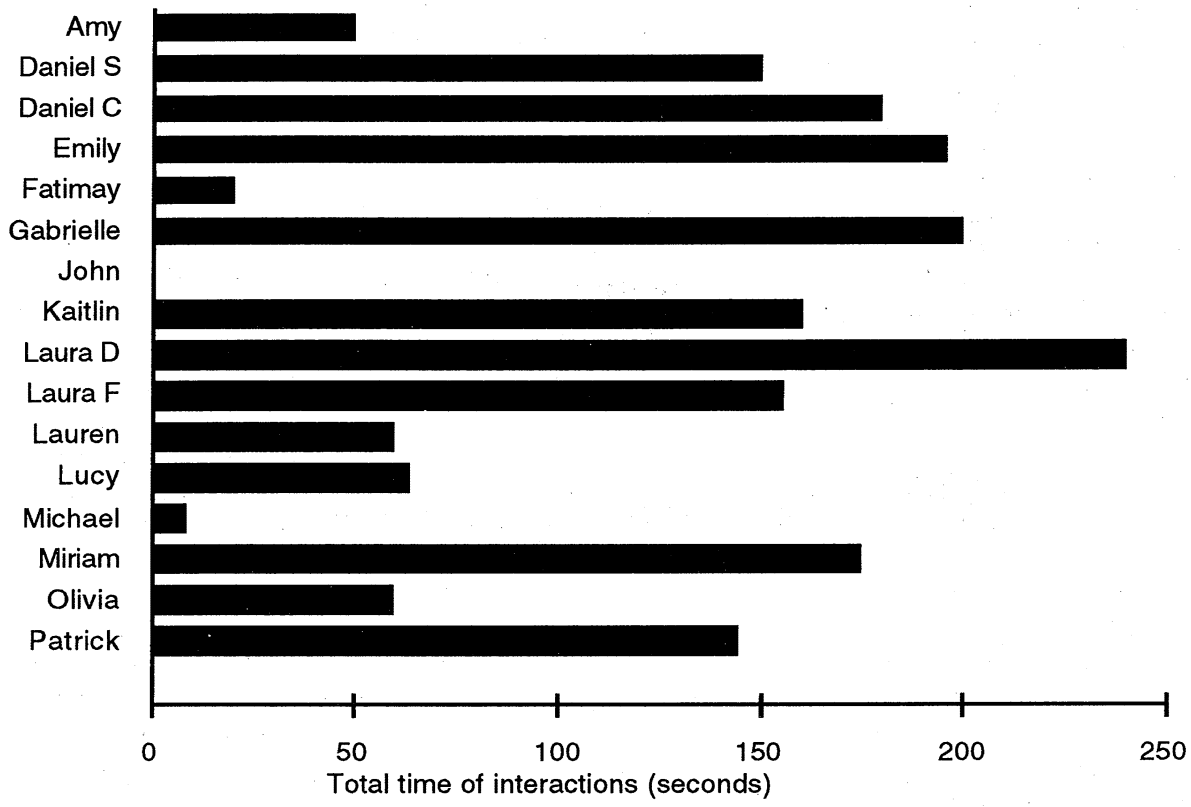

Figure 1: Number of individual children's interactions

The total times of each child's interactions (again mainly with the teacher) were then graphed (Figure 2).

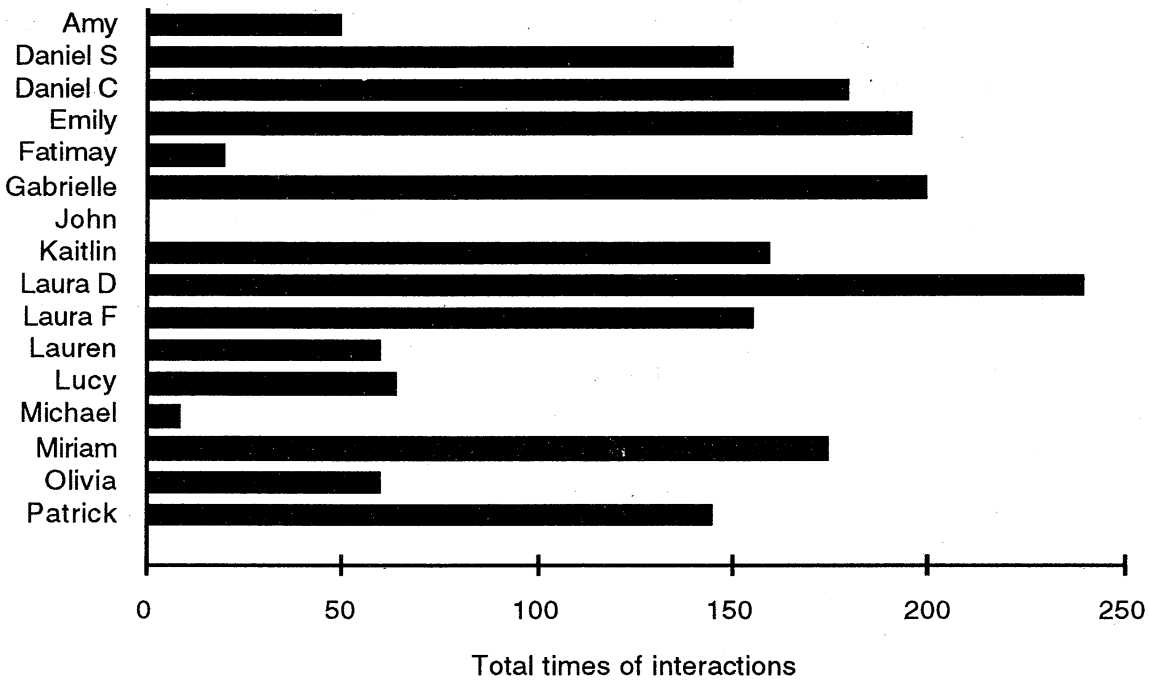

Figure 2: Total times of individual children's interactions

The graph of the number of questions asked by each participant in the classroom (Figure 3) also demonstrated inequability.

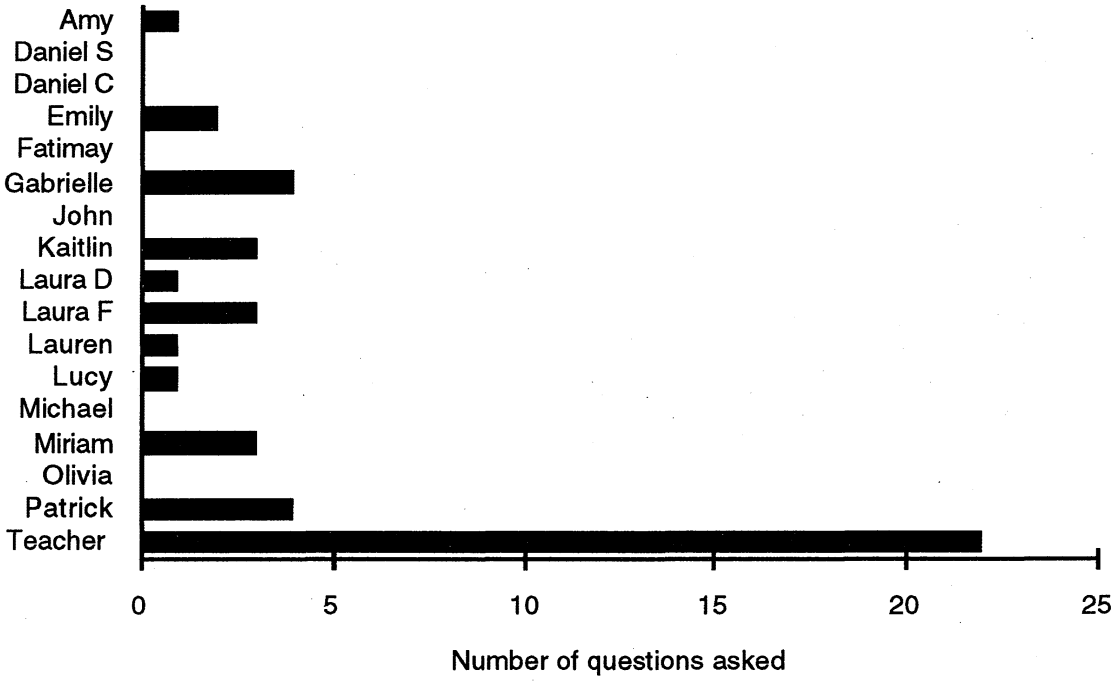

Figure 3: Number of questions asked by lesson participants

It should be noted here that the verbal interactions were those captured by two video cameras whose operators had been instructed to focus on the teacher and the particular children she was dealing with at any time. The data therefore do not include much student-to-student discussion. The data was also from one lesson only, and a further lesson in the same classroom produced different results. It is clear, however, that there were significant differences between the number of verbal interactions contributed to the by individual participants, the amount of 'talking time' used by different participants, and the number of questions they asked in order to clarify concepts and procedures—and these features aroused our interest.

The third incident occurred when a group of graduate students trialing the program noted that the teacher had directed a question to a child who had played no previous part in the class discussion. The girl had appeared flustered and had given a very hesitant answer. The students observed that later questioning by the teacher in a one-to-one situation revealed that the pupil had had a good understanding of the concept and the problem being discussed. This led to a discussion on whether (and if so, how) students should be encouraged to take a relatively equal part in overt exchanges in mathematics classrooms.

The three incidents are related in that each raises questions about the differential status of participants in mathematics classrooms. The creation and sustenance of communication patterns, the claiming or conceding of interaction forms and rights, and the collective or individual nature of responsibility for participation all become topics open to exploration. Further, the incidents suggest the need to debate potential roles for teachers to play in changing patterns of classroom interaction.

Patterns of Communication

In non-institutional social situations, the frequency of people's contributions to discussions, their total time allocation or the number of questions they ask are not controlled, so we rarely feel worried about imbalances or attempt to redress unequal participation. At a dinner party, for instance, there may be some deference to personal status as well as to authority on particular topics, but people generally place themselves within dialogues according to other factors such as their confidence in the situation, their

knowledge of the subject matter, the contributions they wish to make (or to reserve), and the roles they wish to play within the group at that time. Contributions are expected to be uneven, and it is generally accepted that people can be fully involved in discussions by just listening.

Mathematics lessons, however, are not natural social situations. Traditional patterns of control of communication have developed in schools, just as they have in other social institutions (the doctor's office, the witness stand) where one participant has a predetermined communication agenda. Edwards and Westgate (1987) claim that most teachers see close and persistent control over classroom communication as a precondition for reaching their educational objectives.

> From this perspective, classrooms can be aligned with other contexts in which a participant has, or claims to have, prior or superior knowledge of the matters in hand. Where the other participants accept that claim then the talk will be organised by reference to that hierarchy ... the 'expert' will 'control knowledge' by asking the questions, evaluating and shaping the answers in the light of what he or she needs to get the other(s) to say, discarding those which are thereby irrelevant or redundant, and terminating the exchange when enough information has been obtained for the practical purposes of that encounter. (Edwards & Westgate, 1987, p. 46)

Other factors in traditional patterns of communication control may be crowded conditions, the judging of even productively noisy classrooms as poorly supervised, fear of possible consequences of the unpredicatibility of open questions and conversations, entrenched cycles of interaction between teachers and students (T initiation, S response and T comment; T initiation, ...), and the boundaries teachers maintain between learned and ignorant—and hence between producers and receivers of knowledge.

While dominant models of classroom interaction and their implications have been described for years (e.g. Bernstein, 1974; Flanders, 1970; Mehan, 1979), it is only recently that the reverse notion—how discourses are shaped by individuals—has been a focus of research attention. Our use the term discourse here goes further than social uses of language patterns in that it includes the positioning of people within and by such activity. Participants in any social situation are positioned by others within a wider network of traditional power relations, often with institutional bases (Foucault, 1979; Weedon, 1987). These networks and the social interactions within them shape the ways that individuals and social groups see, and therefore portray, themselves. Thus it is through discourse that human identity is developed, maintained or changed.

However, the relationship between discursive activity and identity is a dialectical one, enabling any study of a discursive field to include examination of the way individuals position others and shape its social processes. The ways that classroom participants choose and use words, make meaning, and constitute both themselves and the institutional world through acts of speaking are open to examination (Davies & Harré, 1990). Thus while teachers and traditions of classrooms are dominant factors in determining patterns of verbal interaction in mathematics classrooms, it is possible to observe students working to produce their own identities within, and sometimes against, institutional constraints.

Competing Perspectives

Clearly, there would be advantages and disadvantages in bringing all students into discussions. Making sure that children contribute equally, for instance, would help teach the social skills relating to group discussions—skills of participating and including others. A teacher requiring quiet children (and particularly traditionally subordinate groups such as girls) to contribute would model strategies for facilitating inclusion as well as conveying a clear expectation that all students will be involved in the range of classroom activities. Encouragement to contribute could result in a growth of confidence

after successful attempts are made, leading to more willingness to contribute in future. Responses from all students would enable teachers to judge individual students' understanding and hence adapt further teaching. As articulation of ideas helps to clarify them, expecting students to contribute to a discussion would be likely to lead to improved learning.

However, the notions that there are only some acceptable indicators of participation and that teachers should control all classroom dialogue arise from a didactic model of education where teachers set learning objectives in terms of measurable forms of predictable performance—and then structure, control and evaluate classroom activity in terms of these objectives. Some other models of education that are beginning to impact on pedagogy position teachers not at the centre of activity, but as facilitators of a variety of learning processes. In these models the above functions of social interaction typically become the responsibility of all classroom participants. Using more natural patterns of interaction, students communicate with each other without regular deference to the teacher, even in whole-class discussions. Individuals are not pressured to participate and are not put on the spot through discursive imposition. While such models of educational practice do not deny that curriculum content reaches students through the agency of teachers, they do require flexible patterns of communication within a context of new social relationships and practices.

The didactic model of mathematics education is a powerful one. It is learned in our own schooling, reinforced during teacher training (in both universities and schools) and valued in most professional settings. It was strong enough, for instance, to make the research team question whether graphs such as those above should be included among representations of the high-quality mathematics lessons included in the resource. ('Did teachers agreeing to be filmed give us the right focus on what could be so easily criticised? Why make the unevenness so obvious?') The influence of the didactic model was also strong enough for the issue to provoke extensive discussions amongst the researchers, their colleagues, and students using the draft materials.

We realised that to omit such data would limit possibilities for analysis of patterns of communication in mathematics classrooms and would also mean that we were not drawing fully on the capabilities of interactive multimedia for provoking research into classroom interaction. Exploring the issue of oral participation within competing views of education is not just a matter of counting numbers of interactions or suggesting ways that quieter students can be encouraged to communicate, so linking each component of the graphs with the snippets of video they represent and with written articles that support the styles of communication illustrated would allow a detailed examination of how, and with what consequences, pedagogical processes are structured in particular ways. It would also provide a resource for studying how verbal interactions impact on what is seen as 'mathematics' and what is legitimised, more broadly, as knowledge. As Walkerdine (1990) notes,

> ... the issue of silence and speaking is not a simple matter of presence or absence, or of suppression versus enabling ... what is important is not simply whether one is or is not allowed to speak, since speaking is about saying something. In this sense, what can be spoken, how, and in what circumstances is important. It tells us not only about its obverse, what is left out, but also directs attention to how particular forms of language, supporting particular notions of truth, come to be produced. This provides a framework for examining how speaking and silence and the production of language itself become objects of regulation. (p. 54)

A focus on this aspect of the other media linked with the graphs could also provoke a study of how the teachers and children who were filmed position themselves and each other expertly, not in dichotomous sites of control but on a continuum, speaking and

inviting speech for specific purposes then moving to positions of less control once those purposes are achieved.

Conclusion

We did not set out in writing this paper to present a research report but (in the tradition of post-structuralism) to tell a story of emerging research themes. Concerning communication in classrooms, the story is one of initial surprise, contradiction and reflective discussion; of questioning but not finding answers. In relation to new technologies, it is a story of our developing understandings of the power of a variety of linked media in a new form of research product to engender such questions and hence to provoke educational inquiry. In consideration of research methodology, it is a story about ethical uses of data and the way that particular forms of presentation—while creating opportunities for productive study—may make subjects vulnerable to unforseen critique.

For mathematics teachers the questions raised by this component of our research project are about whether natural communication should be limited in classrooms, and who should be designing communication channels, as well as which parties should be talking, when, and for what purposes. They also relate to how substantive messages about learning (as opposed to schooling) and about the nature of 'doing mathematics' are imparted in different discursive fields.

For mathematics educators and researchers this raises the issue of how to develop a conscious awareness by teachers of their own actions, the reasons for these, and the wider consequences of their teaching behaviours—and then how to facilitate the application of new understandings to the active trialing of new discursive practices in mathematics classrooms. As Walkerdine (1990) states, 'Change is not a matter simply of deconstruction. A new reading permits the possibility of struggle to work for transformation of that sociality, those practices, and of subject-positions produced within them' (p. 57).

Notes 1: This paper was presented at MERGA 18, 1995 in Darwin. However due to an oversight it was not published in that conference's proceedings.

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