Investigating Estimation in the Classroom

Christopher Pike and Michael Forrester
University of Kent

Research into the relationship between language and mathematics in the classroom tends to adopt either the 'language as aformal object' view or a discourse analytic perspective. In our presentation we considered what might be gained from adopting the ethnomethodologically inspired conversational analysis approach, specifically by looking in detail at how estimation is taught and learned in primary school. Beyond highlighting the principles which underpin this approach, the results articulate a number of interesting aspects regarding the ways in which mathematical ideas are transformed into accountable procedures for action in the classroom.

Introduction

Estimation in the mathematics classroom is a topic often cited by politicians and interested parties as a good indicator of mathematical ability. However, a cursory review of the available literature demonstrates that there remain few detailed studies into how estimation skills develop or sufficiently developed theories of estimation itself (Dowker, (1989); Siegel, et al (1982». Our current work focuses on developing a coherent and realisable model of estimation in large part by examining in detail specific skills and abilities said to inform estimating (and approximating - see Forrester et al (1990) for details). One theme of the research is concerned with what we have termed 'social discursive' context skills. **In** particular we are interested to know (a) to what extent children understand the linguistic terms employed in estimation contexts (e.g. just about; around; roughly), and (b) the extent to which they comprehend the discourse context where they learn about (and begin to use) estimation.

In our presentation we concentrated on introducing our current approach to answering how children understand the discourse context of the classroom. However, in contrast to other studies which arguably reflect a 'formal linguistic' approach to mathematical language (e.g. Pimm, (1987» we adopted the ethnomethodological orientation of conversational analysis (after Sacks et aI, (1974». The prime attraction of this approacp is that it predicates the significance of the participant's own understanding of ongoing conversation as the basis for any categorisation or formalisation of the discourse. **In** other words where we are concerned to categorise or classify utterances in the conversations of teachers and their pupils, unless the *participants themselves* display an orientation to the models, metaphors, constructs or ideas which we (as analysts) think are important, then there are no grounds for postulating any other constructs as being relevant. Such an approach has been the subject of considerable debate in

sociolinguistics and social psychology. A summary of the conversation analysis approach can be found in Forrester (1996).

Our aim in the present study was to use conversational analysis as a first step in excavating the implicit models and metaphors in those classroom discussions and activities where estimation was either being taught or practised i.e. the teachers 'formal lessons' introducing the topic, and the childrens discussions when carrying out estimation tasks. It is important to recognise that conversational analysis relies on a micro-analytic level of detailed investigation where talk is recorded, transcribed and then analysed to the point where every nuance, pitch, intonational contour, turn-taking sequence, pause length can be critical.

Conversational analysis is also concerned with the temporal organisation of talk, and with identifying those sequential structures that participants co-produce and orient to (on-line as it were) in the context of an evolving conversation. In order to ascertain whether any particular actions or utterance has specific meaning for the participants themselves it is necessary to examine how stretches of talk (or even a word or phrase) are located in the ongoing conversation, seeing what happens before and after their occurrence and examining in detail how such 'discursive objects' are oriented to (or not). The examples below will provide a flavour of how this is accomplished. For now it is useful to note that during this preliminary phase of our research specific hypotheses (e.g. how teachers might introduce estimating) were inappropriate. Our aim was to uncover the implicit ideas surrounding estimation which might inform how it was being taught and learned. With this in mind we established a number of initiating questions:

* The discursive space surrounding estimation and measurement in classroom talk;

- how are estimation and measurement marked out as distinct discursive objects relative to each other, and to surrounding talk?

- how are estimation and measurement both separated and interrelated within particular kinds of activity and talk (ie.discursive practices)?

* How these relationships change over the trajectory of a lesson

- how are estimation and measurement linearly presented and re-presented by teachers and children during the course of a lesson's talk?

* Criteria for judging the appropriateness of a given estimation or estimating activity

- what do teachers and children demonstrably orient to when accounting for their own estimating behaviour?

* Evidence for conceptual understanding

- to what extent are lessons in estimation, for the children, simply prescriptions for action?

Procedure

We selected at random a number of local primary schools (in Kent) and approached teachers who might be interested in taking part in our research. The findings in this presentation focus on two teachers (with different sized classes) of year 5 and year 6 classes. We also recorded (in sessions some time after our initial recordings) groups of children from these same classes carrying out estimating tasks similar, but not identical to, those we had observed in school (which we set for them). We wanted the sessions to be as 'natural' as possible - so the chance that merely asking teachers to teach estimation could in itself create a situation that might otherwise not have existed was of some concern to us. In order to minimise any observer effect, we arranged the video sessions with teachers so as to slot into their pre-planned schemes of work saying only that we were interested in studying children's age-related estimation abilities. The teachers we recorded were a female class year 6 teacher (class size 22) and a male class year 5 teacher (class size - 30). The children's groups were composed of one all boy group (from class year 6) and a mixed group (from class year 5).

Results and Analysis

For reasons of space our analysis is restricted to the example(s) below. In what follows our aim is both to provide a flavour of what conversational analysis (CA) involves and summarise what we have learned about the teaching and learning of estimation in these particular classrooms. Levinson (1983) notes that "CA is specifically interested in the relationship between intra-turn structure and inter-turn organisation or sequence". Intra-turn structure includes marking (emphasis, stretching, pausing, pitch, transition relevant places and so on). Inter-turn organisation includes turn-taking sequences, overlaps, patterns of repetition and variation. CA focuses on the relationship between these elements so as to highlight how participants demonstrate orientations towards elements of intra-turn structure (e.g. deletion / affirmation / repair / echoing and so on). At all times in the classroom children learn and develop within this organisation of discursive activity.

Keeping in mind the questions outlined above we can consider one small excerpt from our corpus of taped sessions and transcriptions, so as to illustrate the kinds of metaphors and models of what-it-is-to-estimate presupposed in the talk of teachers and children in primary schools.

(DOl) T: we're t GOing to do some work (.) on ((pause)) ..1-measuring. (.) starting with area and perimetei-=Wha::t I want to do is move onto some n~:::w work, but we are going to go over some work which should be quite familiar to you to t start ..1- with.

(1.)

(002) T: and thgt's why you need your general t work books, because you're not tactually going to (.5) use a tru::ler to begin ..1- with.

(.5)

(003) T: t to begin with (.) you are going (.) to do some iEStimating (.) So, tin your general workbook you're going to make (.) a cha::rt which you can then write up into (neat) for thomework

((gap))

(004) T: I~'m going to give each group four sheets (.) and what I want you to do fi:rst of all (.) each shape's got a number on it (.) 1 2 3 4 ((pause)) and so what I want you to do fi:rst of ..1-all (.) as a group (.) to decide wha~t you ..1-think (.) t roughly:: the perimeter of that shape tis and (.) t roughly what you think (.) the g::rea of that shape IS

There are a number of initial comments we can make about the discursive (or problem) space this particular teacher is setting up in relation to measurement and estimation. Keeping in mind that it is the marking, emphasis, pausing stretching and so on that is crucial for this type of analysis, first we can see how' O..1-measuring.(.)' in line 001 and 'tEStimating (.)' in line 003 are clearly marked out from the surrounding talk via the use of pausing, emphasis and changes in pitch. Arguably this marks them out as distinct discursive objects - as objects of talk in their own right, and we can also note that the change in direction in pitch also marks the contrast. Second, in this short extract several of the markings refer to the temporal organisation of the work-to-be-done, most notably 'we're t GOing to do' measurement (line 001), but 'to tstart ..1- with' / ,t to begin with (.) you are going (.)' to do some estimating. Here it is presupposed

that estimation precedes measurement where estimation and measurement are separated in time but related sequentially.

Furthermore, within this temporal organisation we can see in line 002 that measurement is equated with the concrete activity of conventional tool use, when you 'iactually .... (.) use a iru::ler' whereas (in line 004) estimation has to do with the activity of thinking when you \I,think (.) i roughly::', notwithstanding the observation that what-it-is-to-think-roughly is already known to the children. Finally, we can note an orientation towards the production of written work as evidenced by the marking out of 'general iwork books', 'cha::rt', 'for ihomework' and accountability towards the teacher - as evidenced in the emphasised 'should' in line 001.

In this short resume space constrains reporting on the many similar examples in the talk of the teachers (and the children). Summarising briefly what we have found (and with regard to our questions), first the discursive space of estimation and measurement in the classroom is one where (initially during a lesson) they are clearly marked out as separate distinct objects in the teacher's talk. However, although they are related sequentially they are first discussed with reference to two very different discursive domains. Estimation with the hypothetical, with thinking roughly, vagueness, and inexactness, with the practices of guessing and -criticallyNOT using a ruler, in the sense of prohibition. In contrast measurement is all about talk of the actual, the real, with correctness and exactitude, with access to the 'right answer' and using a ruler - the use of the authoritative, institutionalised measuring instrument.

The second major finding is that this relationship between measurement and estimation changes over the course of a lesson. As might be expected, it moves from the conceptual to the practical but there are noticeable changes in the ways that measurement and estimation are represented. Notably the meaning of what-it-is-to-estimate becomes entirely embedded and presupposed within a prescription for activity. And the whole meaning of what it is to 'guess sensibly' and 'think properly' moves out the of the discursive domain of cognition and into that of acceptable and orderly behaviour.

A third noteworthy observation can be made regarding the criteria for judging the appropriateness of a given estimate. It was clear from the recordings (and transcriptions) that these seem to be in terms of the accountability towards the teacher - a 'good' estimate is one judged acceptable by the teacher, one on which access to the ruler as means of discovering the

truth is made contingent. Further, there is a strong orientation on the part of the teachers and children towards the 'right answer' with little or no talk of proximity or purpose.

Finally, analysis of the children's discussions showed that they clearly orient to matters of prohibition and accountability, to the presupposition that measurement follows estimation and to the authority of the ruler (all evidenced in the teacher's talk). However, they also showed a clear orientation towards a model of estimation as 'rough measurement'. Our overall conclusion is that the children demonstrated little evidence of conceptual understanding, their discourse being entirely focused within the domain of practical activity. As for conversational analysis, our current recommendation is that this approach could be of considerable value to researches in mathematics education.

Conversational analysis conventions (after Pathas, 1995).

Code	Transcription conventions employed:
↑ or (↓)	Marked rise (or fall) in intonation
CAPITALS or underlining	Used for emphasis (parts of the utterance that are stressed
::	Sounds that are stretched or drawn out (number of :: provides a measure of the length of stretching
([ ])	Overlaps, cases of simultaneous speech or interruptions
(.)	Small pauses
(1.4)	Silences with the time given in seconds
=	Where there is nearly no gap at all between one sentence and another

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