The Discursive Construction of Learning Mathematics

Jenni Ingram, Mary Briggs, Keith Richards and Peter Johnston-Wilder

University of Warwick

The nature of mathematics, the nature of beliefs about mathematics and what it means to learn mathematics have long been discussion points in mathematics education (Thompson 1984; Boaler, Wiliam and Zevenbergen 2000). The research discussed in this paper focuses on what is said in the classroom during whole class teaching episodes. Using transcripts from two secondary mathematics teachers, we examine how the learning of mathematics is discursively constructed by the teacher and his/her pupils. This conversation analytic approach uses only the content of the interaction to describe the nature of mathematical activity in that interaction. We cannot directly access the beliefs of teachers and pupils, but an examination of how they talk about mathematics reveals how the learning of mathematics and classroom mathematics can be jointly constructed by a teacher and his/her class in quite different ways.

Conversation Analysis, classroom mathematics, discourse.

Introduction

What it means to learn mathematics is at the heart of mathematics education research. Different perspectives have evolved over the years and, with these perspectives, and the developments in technology, new research tools have developed. In this paper, we use a conversation analytic approach to examine the discursive construction of what it means to learn mathematics in two classrooms. The nature of mathematics, nature of beliefs about mathematics and the connections with what it means to learn mathematics have featured in the mathematics education literature for a long time (Thompson 1984; Boaler, Wiliam and Zevenbergen 2000). Even though we cannot directly access the beliefs of teachers or pupils, an examination of how they talk about mathematics and learning mathematics can reveal how the learning of mathematics and classroom mathematics is jointly constructed by a teacher and his/her class.

Conversation Analysis

In this paper, a conversation analysis approach is adopted for analysing two contrasting whole-class episodes. Conversation analysis is underpinned by ethnomethodological principles such as the belief that actions and interactions are socially ordered, and that this order is observable by the researcher and by the participants in any interaction (Garfinkel 1967). The origins of conversation analysis lie in the lectures of Harvey Sacks (1995) and it has since been developed and extended in many disciplines (Drew and Heritage 1992, Schegloff 2007). The key focus of any conversation analytic approach to naturally occurring interactions is how the participants in an interaction jointly create the meanings and activities of the interaction, and how it is that these participants orient to these meanings.

Turns at talk are resources that the teacher and pupils use to perform social acts (Seedhouse 2005) and conversation analysis examines the organisation of these social acts in interactions. Conversation analysis describes and analyses how the participants themselves interpret each other's actions through the construction and order of their turns.

The two extracts included in this paper cannot be adequately understood without reference to the interactional context in which they occur. The aim of a conversation analysis approach to analysing these interactions is to determine which features of the context are relevant to the interaction at a particular moment during the interaction. However, context in the sense used in this paper does not refer to the physical, social or cultural environment that the interactions took place in, but to the context that the participants themselves have made relevant through their interactions. This context is dynamic: what it means to learn mathematics as it is constructed by the interaction can alter and change through the ways in which the participants construct their turns. It is also entirely possible that what the participants describe in their words can differ or even contradict what they are doing in their turns, but this is beyond the scope of this paper.

It is the different possibilities for constructing classroom mathematics by the teachers and pupils that are the focus of this paper. Discussions around what the teachers believe about the nature of mathematics or how pupils learn mathematics are not considered. The perspective makes no attempt to either extend the analysis to the cognitive processes of the participants or to use these processes to explain the participants' use of turns in the interactions, or to generalise to other mathematics that the teachers and pupils do. I first offer a short extract to illustrate how the learning of mathematics and school mathematics is discursively constructed by the teacher and his pupils. A second extract is then offered to demonstrate a contrasting discursive construction of school mathematics. The two extracts considered are chosen because they illustrate the points being made in this paper and cannot be used to make generalisations about the mathematics that the teachers and pupils do in the respective classrooms.

Methods

The two extracts included in this paper are taken from detailed transcripts of whole-class interactions. Video and audio recordings of 17 lessons in secondary mathematics classrooms in the UK were made. Four teachers with a class of 12-13 year old pupils were recorded over a period of 6 weeks, with between 3 and 6 lessons recorded for each teacher. The data collected are considered to be naturally occurring in that the teachers were given no guidance as to what or how to teach and were told only that the researchers were interested in whole-class interactions. These video and audio recordings were transcribed according to the Jefferson transcription system (2004), though for ease of reading, not all features are included in this presentation.

The choice of extracts was based on a need to offer contrasting examples of the discursive construction of mathematics. Both extracts begin with the teacher beginning a task that links to tasks that were completed in a previous lesson. In the first of the extracts these links are specifically mentioned in the transcript but in the second the links are not made until later in the interaction and are not included here. These extracts include instructions of how to complete the task and what is expected of the pupils. Whilst a conversation analytic approach would normally include longer sequences of interaction, restrictions on space make this difficult. The analysis of the

extracts is undertaken within the wider interactional context of the extracts, but only the turns presented here will be the focus of the descriptions offered.

Findings

The first extract presented is a brief extract consisting of two turns of interaction between Simon and Charlie. A brief reading of the extract will soon make the reader aware of the institutional identities of the two participants. Simon is introducing the task, controlling the resources, and controlling who can take the next turn and what can be said in this turn. There are also significant pauses during Simon's turn, during which none of the other participants in the interaction select themselves as next speaker (McHoul 1978, Ingram 2010). Even when Simon has asked a question which requires an answer there is a pause of 0.9 seconds in line 25 where no one self-selects to speak, though a few participants have raised their hands to bid for the turn, and is followed by Simon nominating Charlie in line 26 to take the following turn and in line 27, give an answer to the question. The intonation of Charlie's answer is that of a question, a strategy often used by pupils (Rowland 2000, Ingram 2010) and Simon's turn that follows immediately latches onto Charlie's turn on its completion. Charlie does not nominate Simon as the next speaker.

```
001  Simon:   okay part two:. do you ↑know that little bit of paper I
002           gave you yesterday with the table on and we filled in
003           one side.
004           (1.2)
005           I'm going to a:sk you today to do some practice on this
006           and before we do that (.) I just want to go through
007           another example just to remind everyone
008           (0.3)
009           of um
010           (1.5)
011           of how it's done. so can we just li-, the other side
012           that we haven't filled in.
013           (7.2)
014           it's this one here you should have one, ooops, you
015           should have one that looks a little bit like this.
016           (0.8)
017           ok?
018           (1.1)
019           now I'm going to be honest with you, I was talking to um
020           (1.8) ((teacher pulls down projector sheet and then up
021           again))
022           I was talking to Mrs Smith the other, yesterday and she
023           thinks I'm being much too nice to you when I did this
024           table. do you know why.
025           (0.9)
026           Charlie.
027  Charlie: 'cause you gave us the extra column?=
028  Simon:   =what instead of, ye- ye:s! because I gave you that
029           extra column there.
030           ((teacher points to the third column on the projected
031           table))
032           because (0.4) sometimes in the exam they won't give you
033           that extra column they'll just give you these two, and
034           they'll expect you to know (.) that it might be useful
035           (.) to put this extra column on, do you know what I
036           mean. and in a minute, when you do some practice from
037           the text book it's the same thing. they just give you
038           this bit of the table and they expect you to use your
```

```
039          initiative (.) to draw in the extra column to do it. ok.
040          well let's go through these then, the mo:de, the median,
041          the mean and the range. I think we'll leave the mean
042          till last because it's a bit like the mean one. um Alex
043          and (.) Chris, paying attention now specially, right any
044          offers anyone for telling me what, m-why of course we
045          always want to know why (.) what the mode, the median
046          the mean and the range are.
047          (1.7)
048          …
```

Extract 1 – Simon and Charlie

In this extract, Simon talks about doing "some practice", going "through an example", and filling in a table. Each of these activities is described more than once. He also talks about reminding his pupils of "how to do it", and 'knowing' is referred to again in Simon's second turn. Towards the end of the second turn, Simon constructs a question that begins to ask what the mean, mode, median and range. However, Simon corrects himself (initiates a self-repair) to say that "we always want to know why" before re-asking the question in the form of "what". In the turns that follow but are not included in this paper, each of the mean, mode, median and range are calculated by the pupils and are followed by a brief description of how it was calculated. For example, "three is the mode because it's the most common one." In this brief exchange of three turns, learning mathematics is constructed as going through examples, practicing examples, and knowing and remembering both what terms mean but also how to answer questions.

In this brief extract, Simon contextualises the tasks and activities within a wider context of school mathematics. He positions these tasks and activities within a specific time frame and plan that Simon has for this lesson. He begins by situating the task in respect to what has been done previously. In lines 1-3, this is done by explicitly referring to a previous lesson, whereas in lines 11-12, the reference is more implicit in that the sheet in question has been partially completed in that previous lesson. In lines 23-24 and 28-29 he refers to the preparations that he has made for today's main task, preparing the table which included the 'extra column'. Simon then contrasts what he has planned for the class to do later in the lesson (lines 5-6 and 36-37) to going "through another example" as the next planned task (lines 6-15), which begins at the end of Simon's second turn (lines 40-46).

Simon also positions the tasks and activities in the lesson within the wider mathematics community in the school and the wider examination system. In lines 19-31 Simon refers to a conversation with another mathematics teacher about today's task and then situates this conversation within the context of examinations in lines 32-40, indicating what 'they' (the examiners) will do and providing an insight into their thinking (line 34).

In this extract, the mathematical tasks and activities have been clearly constructed as something that can be described as school mathematics. There is a plan for what the class will do both across a series of lessons and during this individual lesson, and this plan is specifically discussed within the context of preparing and supporting pupils for their examinations. In other words, the tasks and activities are part of a school mathematics curriculum which are endorsed by other mathematics teachers in the department and the examiners.

In the second extract, Tim similarly constructs his turn in such a way that his institutional identity of teacher is clear and, like Simon, Tim is controlling the topic of interaction, the floor and the timing of the activities. There are several significant pauses in which no other participants self-select as next speaker. However, in

contrast to the extract above, two other participants do self-select (lines 25 and 26), and overlap, to answer the question that Tim asks towards the end of his turn. This self-selection occurs after a pause of 0.8 seconds (line 24). However, Tim's reference to doing 'the first one together' in line 22 implicitly directs the question to the class as a whole, allowing self selection and therefore opening the floor to multiple answerers.

```
001  Tim:    Ok
002          (0.6)
003          your fir:st thing today, I've put a problem on the board,
004          I will have a problem on the board in about
005          (0.3)
006          30 seconds, ok I want you to look at that. first question
007          is quite an easy one, the second question we have to need
008          to think about in terms of (.) what it actually means,
009          (1.3)
010          ok. and I want you to try your best and try and understand
011          (.) how far you can get it done, ok. here is your problem.
012          have a go at this. I've just inherited twelve thousand
013          pounds, (0.4) ok and being the generous man that I am I
014          want to donate (.) some of that to charity. but because
015          I'm not totally generous,
016          (1.2)
017          ok. I'm going to donate one quarter of the twelve thousand
018          pounds, then the following week I want to donate a quarter
019          of that amount, following week a quarter of that amount.
020          ok. how much will I donate in each of the first four
021          weeks, the first few are obviously easy. how much will you
022          donate in total. ok let's just do the first one together,
023          in week one how much have I donated?
024          (0.8)
025  Drew:   thre[e thousand]
026  Chris:       [three thou]sand
027  Tim:    three thousand pounds.
028          (3.3) ((writes on whiteboards))
029          wee:k two:, how much am I donating if I'm donating a
030          quarter of that. (.) Harry?
```

Extract 2 - Tim, Drew and Chris

Tim describes the task as a 'problem' that his pupils need to "think about" and "try and understand". He asks his pupils to try their best and "have a go". He also twice describes particular aspects of the problem as 'easy' and contrasts this to aspects that his pupils will need to "think about". In particular, he describes finding a quarter of twelve thousand pounds as "obviously easy" and combining this with his direction of the question to the class as a whole, rather than nominating a specific pupil, he is indicating that the arithmetical calculation is not important and does not need to be thought about. By asking the question to the class as a whole, the likelihood that the answer three thousand pounds is given is significantly higher. It is the question of how much is given away in total that is interactionally constructed as the important question.

In this second extract, learning mathematics is discursively constructed as solving problems, thinking and understanding. There is no mention of practicing, though the pupils do need to do an arithmetical calculation in order to answer Tim's first question. It is also something that the class do "together", which is further reinforced by more than one pupil offering the answer three thousand. Tim uses the pronoun 'I' frequently in his first turn but as a way of personalising the problem. It is he that is giving away the money, not an artificially manufactured individual. Tim switches between describing the pupils as 'you' and including them in 'we', interestingly using the pronoun 'we' when describing thinking.

The extract from Tim's lesson focuses on the 'problem' being discussed. Whilst it is clear that Tim has planned the problem (lines 3-4), Tim makes no attempt to situate the problem in a school context. There are no references to previous or future tasks and activities, there are no shared objectives or outcomes for the problem, and no external agency (such as examiners) is invoked: the discourse is focused on working on the problem in its own right.

Whilst the extracts shared above are necessarily brief, they do illustrate how quickly learning mathematics can be constructed and some of the diversity of the constructions. The analysis above has focused on what Simon and Tim are doing with their turns at that particular moment in time, further analysis is being undertaken of the lengthier sequences of interaction to include a wider range of social acts that the participants perform and the relationships between these and the learning of mathematics.

Transcription Conventions

.	falling intonation contour
?	rising intonation contour
[ ]	onset and end of overlapping talk
(1.5)	pause, timed in seconds and tenths of a second
(( ))	additional information including non-verbal actions

References

Boaler, J., D. Wiliam and R. Zevenbergen. 2000. The construction of identity in secondary mathematics education. *Proceedings of the Second International Education and Society Conference, Univeridade de Lisban*.

Drew, P. and J. Heritage. 1992. Analyzing talk at work: an introduction. In *Talk at Work: interaction in institutional settings*, ed. J. Heritage, 3-65. Cambridge: Cambridge University Press.

Garfinkel, H. 1967. *Studies in Ethnomethodology*. Englewood Cliffs, NJ: Prentice-Hall.

Ingram, J. 2010. The affordances and constraints of turn-taking in the secondary mathematics classroom *Informal Proceedings* 30-3 49-54.

Jefferson, G. 2004. "Glossary of transcript symbols with an introduction". In Conversation *Analysis: Studies from the first generation*, ed. G. Lerner, 43-59. Philadelphia: John Benjamins.

McHoul, A. 1978. The organization of turns at formal talk in the classroom. *Language in Society* 7: 183-213.

Rowland, T. 2000. *The Pragmatics of Mathematics Education: Vagueness in Mathematical Discourse*. London: Falmer Press.

Sacks, H. 1995. *Lectures on conversation, Volume 1*, ed. G. Jefferson. Wiley-Blackwell.

Schegloff, E. A. 2007. *Sequence Organization in Interaction: A Primer in Conversation Analysis (Vol. 1)*. New York: Cambridge University Press.

Seedhouse, P. 2005. Conversation analysis and language learning. *Language Teaching* 38: 165-187.

Thompson A.G. 1984. The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practice. *Educational studies in mathematics*15: 105-127.