Talking to each other: Pupils and teachers in primary mathematics classrooms.

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The paper will describe a theoretical framework which was derived from a small scale study of talk in primary mathematics classrooms. The framework seeks to explore the connections between the mathematical and social aspects of the talk in primary mathematics classrooms in order to consider ways in which teachers work with children to induct them into mathematical discourse. It describes the vital and complex interrelationship between the social purposes and mathematical foci of the interactions and examines the characteristics of conversations that succeed in involving children in expressing and developing their mathematical thinking and understanding.

This paper outlines a theoretical framework for analysing the talk of primary mathematics classrooms which is based on a small scale study of talk between teachers and pupils in a selection of mathematics lessons in primary school classrooms. The study was based on participant observation of a large number of lessons with a small number of teachers and classes from three schools situated in a market town within commuting distance of London. The analysis focused on the detailed study of the transcripts of five lessons. As such this constitutes a fine-grained analysis of a limited amount of data but the data resonates strongly with other data from studies of talk in other classrooms. Examples are presented to illustrate the application of the framework to transcript data.

1. Connections between social and mathematical aspects of talk

In my study I focused on the talk of the primary mathematics classroom and paid considerable attention to social and mathematical aspects of this talk. I based my analysis on ideas about language games and forms of life outlined by Wittgenstein (1968). Wittgenstein’s writings were presented in a series of short disconnected paragraphs so that his work is difficult to interpret and hard to find coherence in. I found Paul Ernest’s (1998) exploration of the relationship between Wittgenstein’s thinking and a constructivist approach to mathematics education particularly helpful in developing my theoretical framework. Wittgenstein’s philosophy was essentially radical, although it has now been adopted into the mainstream, and is social in its perspectives on language, meaning and necessity. Wittgenstein is suggesting that mathematics is based on social agreement about rules and procedures that govern it and as such lacks the infallibility and objective truth that is often ascribed to it. There are several different aspects of mathematics that can be addressed: doing mathematics, thinking mathematically and ‘pieces of mathematics’ or mathematical problems. Wittgenstein argues that all mathematics is socially based. ‘Pieces of mathematics’ or mathematical problems are socially based: they are constructed for people with other people in mind. Doing mathematics could be undertaken as an individual on one’s own but it necessarily involves working within socially agreed practices. Thinking mathematically involves using one’s own reasoning in ways that can be characterised as mathematical but again the dialogue with oneself involved in the thinking is essentially socially constructed. Key concepts in Wittgenstein’s philosophy are the notions of language games and forms of life and I have interpreted language games as the use of language together with the actions that are woven into it. I have taken a form of life to be an established human social practice, established within a community and involving its own purposes, rules and behaviours as well as its own special language games. This means that mathematics can be considered to be a form of life but may not be just one single form of life since it varies in its interpretation between different groups of mathematical practitioners. For instance the mathematics which is established as a form of life in a primary school classroom is likely to be very different from the mathematics established in a community of research mathematicians. Mathematical forms of life are characterised by thinking and reasoning that emphasise exemplifying, specialising,
changing, varying, altering, completing, deleting, correcting, generalising, conjecturing, comparing, sorting, organising, explaining, justifying, verifying, convincing and refuting about number, data, shape and space. These characteristics of mathematical forms of life are based on the work of Anne Watson and John Mason (1998). Mathematical forms of life also involve making connections between mathematical ideas and concepts in a variety of contexts as part of the process of generalising mathematically. This process of generalising comprises conscious mathematical thinking and reasoning and the development of mathematical argument and includes notions of proof.

I examined the language games of the classrooms in which I was working and identified a number of them in the talk of primary mathematics classroom. These included the use of patterns and templates and variations to the IRF (Initiation, Response, Feedback) (Sinclair and Coulthard 1975) sequence of interaction. I also observed the importance of the listeners’ interpretations of the talk in establishing discursive foci (Back 2001) and the important roles of symbols and metaphors in establishing mathematical meanings. I also explored the ways in which teachers engaged pupils with generalising and participating in mathematical reasoning and argument. All these findings were derived from qualitative analysis of the data which was subjected to rigorous scrutiny and the findings were triangulated with a group of researchers to ensure the authenticity of the analysis.

From these findings I concluded that both social and mathematical factors are key to the development of children’s ability to participate in mathematical forms of life. These aspects of classroom talk have been addressed by a number of other researchers but, owing to the limitations of the length of this paper, I am unable to consider them here. At this stage I sought to find a framework to take account of mathematical and social aspects of the talk that would give some indication of the extent to which the talk might be enabling children to participate in mathematical forms of life.

I will begin outlining my framework by considering a brief excerpt from a lesson with 8 and 9 year old pupils about the factors of large numbers in order to illustrate the qualities that the framework seeks to identify:

Example 1: Factors and Multiples: Lines 40 – 44: A factor of 132

40 T: Right. Number one. Give me a factor of one hundred and thirty two then. Just give me one of the ones that you've chosen. Neil?

N: Two

T: How do you know that two is a factor of a hundred and thirty two, please Ryan?

R: Because a hundred and thirty two is an even number.

In this exchange the teacher asks two questions: firstly she asks for a factor of the given number and then she asks for a reason for choosing that factor. The two questions are very different. The first question is asking for a claim to be made whereas the second is asking for a reason why the claim is valid, or a warrant. It would have been possible to pursue this further and ask for a backing, or a further warrant, to support the first warrant but in this lesson the teacher rarely did so. The evidence from this excerpt of an argument based on mathematical reasons and justifications is strong.

This excerpt illustrates the different functions that questions can have in the talk of the classroom and shows how the teacher can be involved in helping to structure the argument through the course of the lesson. She is asking her pupils to think of reasons ‘why?’ in the case of each number offered as a factor rather than just to focus on the factor given as ‘the answer’. Such an approach is indicative of very different intentions on the part of the teacher from an approach that focuses just on the right answers. This in turn implies the valuing of different forms of life. A teacher focusing on right answers and structuring her lesson on IRF sequences is not asking for engagement with mathematical reasoning to the same extent as this teacher. In offering feedback immediately after
the answer is given, the emphasis is placed on the ‘right answer’ rather than any mathematical reasoning that might lie behind it. In contrast the adjustment to the normal IRF sequence which asks for reasons or justifications before offering feedback shifts the emphasis of this lesson onto mathematics that is focused on reasons and justifications rather than correct answers. By the same token it would be possible for the teacher to pursue the mathematical reasoning and ask for substantive backing to support the warrant. This would be indicative of an even stronger focus by the teacher on mathematical forms of life that reflect mathematical thinking and reasoning. In developing the dimensions as outlined below, I am seeking to construct an analytic tool that helps to consider how these differences can be identified.

This teacher has made a shift away from the standard IRF exchange to following up answers with further questions that demand higher levels of mathematical thinking. This is illustrated throughout the full transcript of the lesson so that the most common sequence becomes IRQRF (initiation, response, follow up question, response, feedback). This shift may seem small but can be crucial in changing the practices of the classroom. Julie Ryan and Julian Williams’ (2002) paper considers argumentation in mathematics lessons and suggests that such small changes:

involve an apparently small but fundamental shift in discursive practice: changing cultural practices in teaching is never trivial. (p. 90)

They are concerned to explore how children develop and show their understanding through participating in argument. Their aim was to enable teachers to manage discussion in mathematics classrooms that was focused on mathematics. They found that the management of such discussions by teachers was a real issue for the teachers concerned even when the researchers set up a problematic by suggesting a valid starting point for the discussion. The skills involved in managing to help children to voice their conceptions, listen to alternatives and clarify and develop their arguments were considerable at the small group level. They found that these were further complicated at the level of whole class discussion and that the teacher needed to slow down the pace of the lesson to ensure that the majority of the children were able to follow the ideas that were being expressed.

These findings suggest that the management of the talk of the classroom is complex as well as the talk itself and, in the management of the talk, social aspects play a crucial role. I suggest that the central language games of the primary classroom that contribute to pupils’ participation in mathematical forms of life are those that involve generalising, reasoning and argument. I will use these ideas to develop a framework to help to analyse the social and mathematical components that contribute to this participation.

In devising this framework I am trying to raise the level of analysis above that of an utterance by utterance approach to explore how the language games in mathematics classrooms might help to induct pupils into mathematical forms of life. There seem to be components of the social aspects of the interaction and also of the mathematical aspects of the interaction that can work in quite distinct ways, sometimes working against each other and sometimes in conjunction to facilitate the induction of pupils into mathematical thinking and expression.

1.1 Dimensions of classroom talk

My model suggests that every utterance in the talk can be analysed in relation to its social and mathematical components and I want to suggest that these components can be viewed as dimensions of the talk as illustrated by the following diagram:

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**Figure 1: Dimensions**

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The social dimension of talk is connected with building and maintaining the social relationships within the class, between teacher and pupils and between pupils. There is a sense in which all the talk is social: it involves social interaction between the participants. However I am interested in the contribution of the talk to the social contexts of the learning environment that the teacher and pupils are creating.

The mathematical dimension is concerned with the mathematical component of the talk and relates to the way in which the talk contributes to mathematical forms of life, particularly those that support mathematical thinking and reasoning. I am interested in the contribution of the talk to the mathematical contexts of the learning environment that the teacher and pupils are creating.

In order to develop some sort of scale along these dimensions, I would suggest that the social dimension can vary from open to closed depending on the emphasis of the utterance in terms of its contribution to the social relationships within the class. Openness on the social dimension would suggest contributing to open relationships that encourage pupils and teachers to view themselves as joint participants in the learning and teaching processes. Closedness would be linked with rigid interpretations of the participants’ involvement and force them to follow predetermined patterns of contribution to the talk.

The mathematical dimension can vary from low to high depending on the emphasis of the utterance in terms of its contribution to the mathematical contexts of the learning environment in the classroom. A high mathematical dimension would suggest that the utterance was closely linked with mathematical forms of life that take account of mathematical thinking and reasoning. A low mathematical dimension would suggest little relationship to these forms of life and might possibly reflect an instrumental understanding of mathematics.

### 1.2 Dimensions and ‘real’ classrooms

It is clear that my identification of mathematical and social dimensions of classroom communication is not unique and other researchers have investigated their relationship. My findings differ from those of some researchers in that they were gathered from ‘normal’ classrooms rather than in an experimental setting. As such they offer the opportunity to observe practices that are occurring with minimal researcher intervention. My work focused on teaching and learning in ‘ordinary’ classrooms and explored the factors involved. In primary schools the main focus tends to be on the learner and learner development rather than the mathematics that needs to be covered. This had implications for my analysis of the transcripts as it made the social as important as mathematical.

The perspectives offered by a number of different researchers have informed the development of my framework. These include Basil Bernstein’s concept of framing (1971), Margaret Brown’s analysis of levels of mathematical learning (1979) and Barbara Jaworski’s ideas about the teaching triad of sensitivity to students, management of learning and mathematical challenge (1994). Further information about the links to the work of these researchers can be found in my thesis (Back 2004).

### 1.3 The social dimension

In separating the social from the mathematical, I am seeking to draw attention to the effects that different approaches to teaching and learning have on classroom talk and the ways in which the talk serves to induct pupils into mathematical forms of life. I hope that this will help to illuminate the ways in which social and mathematical components of the talk interact to facilitate or inhibit participation by the pupils in mathematical forms of life. The pedagogical relationships between
teacher and pupils are built up over time through the course of the ‘long conversation’ that they share. The social dimension is affected by the contexts of the school as a whole. The personalities, both of the teacher and her pupils, will influence the social dimension. Some aspects of the social component of the talk are connected to organisational aspects of classroom phenomena.

Both the teacher and her pupils can and do have an effect on the nature of the social interaction that takes place in the classroom. In settings in which the social dimension is open, there are opportunities for teacher and pupils to negotiate the exchanges that take place. Pupils are able to ask questions and to challenge the assertions that are being made, even the teacher’s assertions. From my transcripts I have a number of examples in which pupils take the initiative in negotiating a discussion or even possibly wrest control from the teacher. For example, Yaseen in the lesson about factors of large numbers contests the teacher’s control of the talk. He even asks her what question is under discussion, which runs counter to standard interaction patterns, in which teachers ask questions and pupils supply answers. In another lesson a small group of children worked on problems involving finding the missing numbers in a pattern involving addition. John, one of the pupils involved, also contested the teacher’s authority in relation to the mathematics (See example 2). He seemed to feel confident enough in the social setting to enter into a genuine discussion about the sizes of numbers with the teacher. I would describe these contexts as open socially. However in both the lessons from which these examples are taken the teacher’s control over the mathematics and what counted as mathematics in the talk was strong so that talk that is open socially may occur with different levels of control by the teacher of the mathematics under discussion. My conception of the dimensions is capable of analysing the social and mathematical components separately in order to explore the effect that one has on the other.

1.4 The mathematical dimension

I would like to suggest a mathematical dimension that will vary from high to low depending on the nature of the mathematical content of the utterance. For example the teacher may ask a question of a pupil that has a high or low mathematical component. ‘What is three times four?’ is a question with mathematical content but it has a limited or a low mathematical component. It relates to Brown’s level of simple recall. ‘How would you find all the factors of twelve?’ is a question with a higher mathematical component as it is seeking to elicit mathematical thinking and reasoning and has some element of problem solving. ‘Do you have the answer to question eight?’ is not a mathematical question at all and so has no mathematical component. However it is possible that the response to the question might be a statement with a high mathematical component and show evidence of mathematical thinking and reasoning as well as problem solving. Utterances with high mathematical components show evidence of mathematical thinking and reasoning and various other characteristics of mathematical forms of life.

I consider conscious mathematical thinking and reasoning, involving generalising and the development of mathematical argument and including notions of proof to be central to mathematical forms of life. An utterance which is low on the mathematical dimension might exhibit simple recall or algorithmic learning in the sense of routine repetition of an algorithmic procedure. With higher mathematical dimensions utterances would show more comprehension of the procedures, more relational understanding and more application. Increasing levels of mathematical thinking and reasoning and attention to mathematical argument are involved in conceptual learning and problem solving strategies which suggests that these would rate as high on my mathematical dimension. My emphasis in this paper is on the participation of children in the talk of the primary mathematics classroom and the extent to which that participation showed evidence of mathematical forms of life involving mathematical thinking and reasoning. The key elements in this are generalising, developing mathematical arguments, mathematical reasoning and thinking. My emphasis on these aspects reflects the central place they hold in mathematical forms of life.
The mathematical dimension of a sequence of utterances can be considered to be high when the teacher and pupils extend the mathematical component beyond the recall of procedures toward participation in mathematical argument, mathematical thinking and reasoning. This cannot be characterised on the basis of the teacher’s questions alone but needs to take account of the responses of the pupils. The mathematical thinking and questioning needs to reflect the characteristics described earlier in order to be characterised as high level. These link closely with mathematical problem solving and conceptual learning. However I would also stress the importance of the social dimension of the process of inducting children into mathematical forms of life. In exploring this connection between social and mathematical I hope to enhance the understanding and analysis of classroom talk.

In considering the mathematical component of questions and statements some interpretation of the expectations of the person posing the question or making the statement needs to be made in terms of the response they intend to elicit. This also applies to considering the social dimension of utterances. There is a place in mathematics lessons for statements and questions with both high and low mathematical dimensions but I suggest that an exploration of the mathematical dimensions of utterances will be fruitful in exploring the induction of pupils into mathematical forms of life.

The mathematical dimension or social dimension could be different in the same utterance. For example the question in the first example quoted above: ‘How do you know that two is a factor of a hundred and thirty two, please Ryan?’ has a fairly high mathematical component as it asks for a mathematical justification for an answer. However it is closed socially because it requires a response from one nominated pupil who is expected to offer the justification in response to the question.

On the basis of this theoretical exploration of the mathematical dimension I suggest that the mathematical dimension of an utterance is dependent on the contexts in which it occurs and can only be evaluated in relation to those contexts. The contexts of the utterance include the setting of the specific lesson and its artefacts, the situation in which the classroom is set and also the schema of the participants. These need to be interpreted carefully and with close reference to the surrounding utterances to ascertain possible interpreted foci of the participants. The mathematical dimension is affected by the teacher’s perception of mathematics as a school subject and also more broadly by school and societal influences on classroom practices. It is affected by the artefacts that are used in the lesson such as materials, equipment and worksheets. It is affected by the way in which the lesson is organised and structured and also by pupils’ perceptions of the task and concepts involved in the lesson.

I feel that there is some gain to be made by separating the social and mathematical dimensions. This enables one to explore those strategies that are common across teaching and learning situations generally and those that are special to teaching and learning mathematics and that may be related to mathematical forms of life. In identifying the social and mathematical dimensions of the talk I hope to disentangle some of the complex issues involved in classroom talk and present them more clearly in the contexts of primary school mathematics classrooms generally.

1.5 The contribution of the framework to consideration of talk in classrooms

In my analysis so far I have identified the social and mathematical dimensions of the talk as both playing a vital role in primary mathematics classrooms. The theoretical position that I am suggesting is that, in the context(s) of primary school mathematics lessons, teachers are involved in integrating these social and mathematical aspects of the talk of the classroom to facilitate teaching and learning. I would contend that an examination of utterances from such lessons in terms of social and mathematical dimensions will prove productive and enable discrimination between the lessons to take place. This would further our understanding of the strategies that teachers can adopt
to ensure the participation of pupils in mathematical forms of life, assuming that such participation is part of the teachers’ intentions.

At this stage I am putting forward the suggestion that it is impossible to have a lesson in which the talk is closed socially but has a high mathematical component. This would lead to the conclusion, if it were true, that inducting pupils into forms of mathematical life that emphasise mathematical thinking and reasoning is dependent upon communication that is open socially. It would also imply that children need to be active participants in the discourse and engage in the mathematical tasks with interest if they are to be inducted into mathematical forms of life. I will now consider this suggestion in relation to the data that I have gathered in the course of my research.

To summarise the ideas behind the framework: I have focused on mathematical and social dimensions of the talk as reasonable key notions that are central to classroom talk. The mathematical dimension is considered to be high if the talk is strongly related to mathematical thinking and reasoning. This contrasts with talk with a low mathematical dimension that would be limited to recall of knowledge about facts or algorithms. By identifying talk that is high in the mathematical dimension and examining its social dimension, I will be able to explore the relationship between these two components. I am interested in talk that shows strong evidence of reasoning: answers from pupils that show mathematical thinking or questions from teachers that elicit or provoke thinking and reasoning. I will also examine the social dimension and look for evidence of talk that is open socially so that pupils are given opportunities to make contributions with some degree of autonomy.

2. Applying the framework to episodes from lessons

In this section I will illustrate the value of the framework by applying it to an episode from a different lesson which I would suggest is a ‘telling case’. The intention is to use this as an illustration of the potential of the framework. The following excerpt is taken from the lesson on ‘Triangular Walls’ which was a worksheet involving filling in missing numbers in a pattern that involved addition.

Example 2: Triangular Walls: Lines 189-200: The biggest number

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Oh no! Oh no!</td>
</tr>
<tr>
<td>190 T</td>
<td>Don't worry about these ones down here, these are really difficult.</td>
</tr>
<tr>
<td>L</td>
<td>Yes I'd need about a thousand square</td>
</tr>
<tr>
<td>T</td>
<td>A two hundred square I think!</td>
</tr>
<tr>
<td>L</td>
<td>A two hundred square, yes I would! (…)</td>
</tr>
<tr>
<td>T</td>
<td>The biggest number is one hundred and fifty.</td>
</tr>
<tr>
<td>195 J</td>
<td>The biggest number in this is one hundred and fifty.</td>
</tr>
<tr>
<td></td>
<td>(…)</td>
</tr>
<tr>
<td>T</td>
<td>Just carry on till you finish.</td>
</tr>
<tr>
<td>J</td>
<td>The biggest number is a trillion</td>
</tr>
<tr>
<td>200 J</td>
<td>I don't think about it! (laughter)</td>
</tr>
</tbody>
</table>

At this stage in the lesson the pupils were moving on to solving some triangular walls that involved larger numbers and were finding that their facility with arithmetic was being taxed. To start with they had been using rulers as number lines to help to add the numbers. They went on to using a “hundred square”. The question that Lenny was considering was the answer to 76 + 74 and he started by speculating about how big his number square would need to be to solve such a problem.

The exchange had elements of many of the characteristics that I explored in the course of my study. There was use of indexical expressions that were only clear to the participants from the contexts of
which they were aware. The teacher revoiced the pupils’ utterances and there was the development of an argument. Lenny seemed put off by the size of the numbers and suggested that he would need a bigger number square to cope: he suggested a thousand square but the teacher countered this by suggesting that a two hundred square would do. Lenny agreed. This involved a suggestion and a counter suggestion. The teacher then made a claim: the biggest number is 150 which another pupil, John, countered again by modifying the suggestion with the proviso ‘in this’. The argument was then developed further between John and the teacher with a generalisation that took it beyond the limits of the task on which we were working.

I will now consider the mathematical and social dimensions. In the first utterance the pupil’s ‘Oh no oh no!’ there was no explicit mathematical element although he was responding to concern about the difficult numbers. Throughout the excerpt there was a sense of social banter between the teacher and the pupils and a sense of fun about what they were doing. This was evident from the tones of voice of the participants on the audio tape. The element of playfulness, I would like to suggest, can play a key role in taking the pressure off children, when they are involved in mathematical thinking that is actually difficult for them. I would suggest that the utterance ‘Oh no, oh no!’ shows openness on the social dimension as the pupil was willing to express his anxiety. The teacher responded with ‘Don't worry about these ones down here, these are really difficult’ which might have served to acknowledge that the anxiety was real but that they could cope with it. This has a social dimension showing the teacher understanding her pupils’ anxiety about the difficult numbers and closing down the anxiety. It also shows evidence of the teacher’s sensitivity to her students and of awareness of the mathematical challenge of the activity. This awareness of the difficulty of the mathematics makes the utterance quite high on the mathematical dimension but it also shows sensitivity about the potential anxiety that makes it open on the social dimension. At the same time there is interplay between the mathematical and social which is important in terms of recognising the social and mathematical aspects involved in learning mathematics even though the mathematics remains implicit.

The next three lines go on to focus on mathematics and reveal a high mathematical content:

L: Yes I'd need about a [thousand square
T: [A two hundred square I think!
L: A two hundred square, yes I would! (...)  

The pupil started by wondering how big the number square would need to be to solve the problem. He suggested ‘a thousand square’ and the teacher suggested a ‘two hundred square’ as big enough for this problem. It would have been interesting to explore the pupil’s reasons for suggesting a ‘thousand square’ but the opportunity to do so was ignored by the teacher. These three utterances are all high on the mathematical dimension as they are related to the mathematics in the task not just the procedures surrounding its completion: the discussion is about the relative sizes of numbers as well as the ‘hundred square’ tool. This relates back to the key elements of mathematical thinking and reasoning which are associated with the ability to generalise both within and between mathematical contexts and also to develop mathematical arguments involving conjectures, exemplifications, justifications and reasoning. In suggesting a thousand square Lenny was predicting the limit of the largest number that can be made with three digits and the teacher’s comment restricted the discussion to the limit of the largest number that can be made by the addition of two digits. The exchange is also fairly open as the pupil is not limited to a predictable answer to a set question. Not only are the utterances mathematical in content, the exchange also demands engagement with mathematical thinking from the child.

The social relationships in the excerpt are relaxed and the pupils are free to make unsolicited contributions in this small group of six pupils. The social openness in this example is shown in the ways in which the teacher makes suggestions and also in the response she receives from the pupils.
The pupils make spontaneous contributions and comments about their work and are not restricted to answers to the teacher’s questions.

In terms of the social and mathematical dimensions in the excerpt, we have flexible social relationships shown in relaxed social interactions and a high level of mathematics in the utterances. There are shifts in the teacher’s control of the exchanges both socially and mathematically which demonstrate flexibility rather than rigid structures. The pupils also exert control over the flow of the exchange and do so quite strongly.

This excerpt can only serve as an illustration of the quality of talk in this classroom. By way of contrast consider the following example:

**Example 3: Counting On: Lines 32- 46: Two numbers or one?**

| T: | That's right. Number 9 (teacher writes '9') and number 10, two numbers or one number? (teacher pauses and looks at pupils) |
| Chn: | Two |
| T: | What number do we need to go first? |
| 35 Chn: | 1 (teacher writes '1') |
| T: | and zero (teacher writes '0') Freddie's group, which bit is the zero? (teacher points to '0') |
| Ch: | Units |
| T: | Units. No units (teacher points to '0') and 1 ten (teacher points to '1' in '10'). Right. |
| 40 T & C: | 11, (teacher writes '11'), 12, (teacher writes '12') 13, 14, 15, 16, 17, 18, 19, 20 (counting together while teacher writes on board) |
| T: | So. Right. Let's think of a number between zero and 20. Put your hands down, I'll choose someone. Anthony would you like to think of a number for us? |
| A: | Two numbers between zero and 20? |
| 45 T: | No just one number |
| A: | 10 |

In this excerpt, I would suggest that the level of the mathematical dimension of most of the utterances is low: the children are asked routine procedural questions to which they have a limited number of possible answers. The exchange is also closed socially with no opportunities offered for pupil contributions, other than in direct response to elicitations from the teacher, and that even then the range of options is limited. It is difficult to see how such exchanges contribute to enabling children to participate in mathematical forms of life that involve mathematical thinking.

There is some evidence from the transcripts of variations in the mathematical dimension between different teachers as this second excerpt illustrates. There is also evidence that the teachers, who induct their pupils into mathematical forms of life, are more skilled at balancing the social with the mathematical. They have a stronger grasp of the mathematics and take the lead on mathematical thinking and reasoning. This evidence indicates that what the teacher brings to the talk of the classroom in terms of subject knowledge is equally important to their knowledge of the processes of coming to know mathematics. An open social setting seems to be essential for children’s mathematical voices to be heard. If the children are exposed to highly mathematical talk but do not have the opportunity to express their mathematical thinking or voice their mathematical ideas they are unlikely to develop as participants in mathematical forms of life. If children are able to engage in discussion freely and express their ideas but are not exposed to talk that is highly mathematical they are again unlikely to become participants in mathematical forms of life. This lends further support to the hypothesis that inducting pupils into mathematical forms of life requires not only talk with a high mathematical dimension but talk that is open socially.
My thesis is therefore that classroom talk must be socially open if pupils are to be inducted into mathematical forms of life. However although this is a necessary condition it is not sufficient. The mathematical dimension of the talk must be high as well. Similarly talk with a high mathematical dimension is not in itself sufficient to ensure the induction of pupils into mathematical forms of life. The social dimension must be open as well. This suggests that there is a dialectical relationship between the mathematical and the social dimensions of the talk and that the successful induction of pupils into mathematical forms of life is dependent on talk that is both high in its mathematical dimension and open socially.

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