

ESTABLISHING A MATHEMATICAL COMMUNITY OF PRACTICE IN THE PRIMARY CLASSROOM

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Abstract

This paper draws on a study of children's learning of early addition in primary classrooms in England and considers one teacher teaching mathematics to her class of 4 to 6 year old children who have had little previous formal schooling. Lave and Wenger's social practice theory is used in order to show how the teacher and children develop a mathematical learning community. This mathematics classroom is shown as a place where the children work together participating at their own level, building on the contributions of others, developing a shared understanding of the mental and physical mathematical resources used, and beginning to see themselves as able mathematicians.

Introduction

Teaching children at the beginning of their schooling requires the teacher not only to introduce academic subject learning but also to establish the norms and routines of schooling. Children are organised for learning, in whole class situations, groups or individually, with different sets of rules for different settings and subject areas. Behaviour is managed and modified through rules and reminders. Children are expected to take turns to interact with the teacher, not all demand attention at once, to put up their hands if they want to talk.

A subset of these norms and routines relate specifically to the learning of mathematics. Some of the same expectations apply across all areas of the curriculum but some are different. This can be seen in an example from another class in my study in which a four year old child was uncertain why, when asked to draw a picture of what he did on holiday the scenery and people were important, while when asked to draw a picture of what he did in the mathematics lesson he was expected to attend only to the fine detail of the activity, the number and number operations modelled with the materials given.

Analysis of data relating to a study of how young children learning addition in primary classrooms in England revealed offers insight into establishment of a learning community. This paper will discuss the data from the perspective of a social theory of learning within a community of practice (Lave and Wenger 1991), which places learning 'in the centre of our lived experience of participation in the world' (Wenger 1998 p. 3), in order to describe how the teacher and children create such a learning community in the classroom.

Social practice theory

Lave and Wenger assert that all learning has a social origin for “there is no activity that is not situated” and learning is a process whereby “agent, activity and the world mutually constitute each other” (Lave and Wenger 1991, p.33). The starting point for learning is not the individual but the social practice in which the community is engaged. So, Lave and Wenger describe learning as situated in ‘communities of practice’ and describes how ‘newcomers’ to the community become more knowledgeable in the practice through a process of ‘legitimate peripheral participation’, a bridge between the individual and the community of practice. Through such participation the individual learns to become a full member of the community, to reach full participation and become an ‘old-timer’.

Adler (1998), in her consideration of this theory for the mathematics classroom, notes that full participation is not “an endpoint in learning/knowing all there is to know about the practice” (p.165), but involves mastery - having control over the resources (physical and mental) present in the practice. Learning within the community of practice requires these resources to be accessible to the learner, and Lave and Wenger describe two ways in which this mastery can develop. First, it is developed as a result of transparency (1991) whereby the learner is able to see not only what to do but why, and with this knowledge mastery, rather than imitation, is achieved. Such transparency, or the lack of it, can “enable, obstruct or even deny peripheral participation and hence access to the practice” (Adler 1998, p.167). Secondly, legitimate participation involves “learning how to talk (and be silent) in the manner of full participants” (p.167). Lave and Wenger assert that “the purpose is not to learn *from* talk as a substitute for legitimate peripheral participation; it is to learn *to* talk as a key to legitimate peripheral participation” (1991, p.105, original italics).

Social practice perspectives on learning mathematics in school

Adler observes that social practice theory faces its greatest challenge when we try to apply it to the practice of teaching and learning in schools (Adler 1998); for, if we are to describe the mathematics classroom as a community of practice, what is the nature of the practice - teaching, learning, mathematics? Who are the old-timers - teachers or older pupils - and what are the newcomers learning to become? We cannot say that they are learning to become teachers since this will apply to few of them. Few, also will become mathematicians, even if teachers see themselves as mathematicians, yet mathematics is what they are doing. And what is the *product* of the community of school mathematics learners? Adler sums these questions up in asking “what might constitute legitimate peripheral participation in the mathematics classroom (p.169). In this sense it is difficult to see how the mathematics classroom can be equated to the work, or even the social, contexts of adults. The children are not there by choice (Ernest 1998) if they share the aims of the teachers these are seldom made explicit.

The newcomer / old-timer, peripheral and full participation models appear to break down.

Adler, however, goes on to argue that “Lave and Wenger have, nevertheless, constructed concepts that could provoke insights into learning and teaching mathematics in school” (p.170). In particular she notes the relevance of transparency to the use of resources (physical and mental) for learning mathematics in the classroom, where the child may find the resource opaque and so focus on the resource rather than on the underlying mathematics. This opacity of resource can lead to alienation from the practice. Furthermore, Adler relates talking within and about mathematics to the difference between children using language to help solve a problem and that used to explain it to others. In an attempt to explain the sense in which the classroom is a community of practice she draws on idea of *discourse*, “language as it is used to carry out the social and intellectual life of a community” (Mercer, 1995, p.79). Adler argues that the discourse of the classroom is not that of the mathematician, nor the apprentice, nor the everyday, but that it is a distinctive discourse “a social practice with specific time-space relations, activities and discursive practices. School mathematics is a distinct practice. A hybrid where there are recontextualisations from the discipline of mathematics and its applications into the curriculum” (p.173).

So, Adler argues that social practice theory has clear relevance to the classroom, but that the mathematics education community may still need consider how it may be useful (though see Watson 1998 for further discussion). To date, there has been little published research on the relevance of social practice theory to early mathematics education.

Context of the research

This paper describes the practice in one classroom in a city first school (children aged 4 to 9 years). At the time of the research, the class consisted of 27 children between the ages of 4 to 6, who had previously spent between 0 and 4 terms in the school. Children are accepted into school the term before their fifth birthday. A few of the older children had spent one term with another teacher, while for most this was their first class for formal schooling. The teacher, Debbie, had been teaching for three years, having trained as a mature student. The class used some scheme books for practice tasks and Debbie drew on a range of resources for teaching ideas.

The methodology was qualitative, with participant observation the main method of data collection. Detailed fieldnotes were taken of all mathematics lessons observed; short unstructured interviews with teachers were carried out before and after the lessons. The data was analysed using a grounded theory approach (Strauss and Corbin 1990), which produced patterns of recurring variables. Analysis of these variables, grounded in the theoretical framework of the researcher, provided analytical pictures of teaching and learning, from which the findings emerged.

Establishing a community of practice in the classroom

This section describes some of the ways in which Debbie and the class established a mathematical learning environment. It uses selected examples from the lessons observed to illustrate particular aspects related to social practice theory, though these were by no means the only examples that could have been used.

Legitimate peripheral participation

One of the early mathematical practices carried out in Debbie's classroom was that of counting. This was not only the cardinal counting of small numbers of objects, but also the rote learning of counting strings extended to large numbers and step counting. For example, during a lesson using a hundred square, Debbie had highlighted the multiples of ten down the right hand column, and she and the children counted in tens:

Debbie Shall we, er, count with me and we'll go all the way down
 to one hundred and then see if we can keep going.

Together 10, 20, 30, ... 100, 110, 120, 130, ... 190, 200 ...

Some children are still counting with Debbie on two hundred, others saying a hundred and twenty, all picked up again at 210. They continued counting to 800.

Debbie I am absolutely amazed. Give yourselves a big clap. Can
 anyone tell me what happens after 970, 980, 990?

Zeb 991, 992

Will A thousand

Rita it goes on and on.

Many of the children were not confident in keeping track of the hundreds as they counted and they relied on Debbie to provide the next hundred name, but were very good at the pattern of tens. When counting together there was no expectation that every child would be able to do everything. In other lessons, when the counting got harder (e.g. counting backwards in 2s from 15), some of the younger children soon got lost and began to 'mouth the words', or gave up altogether. However they were still listening to and experiencing the counting sequences, building on their experience of number.

The children are participating in a social act, joining in as far as possible, learning from one another and from the teacher. In Lave and Wenger's terms they could be seen as involved in legitimate peripheral participation; participation in the very localised, social practice of counting, a practice in which the teacher is 'master' and the children 'apprentices' at differing stages of becoming full participants (1991).

Transparency of mathematical resources

In Debbie's class much of the mathematics was carried out with the whole class group. There was a heavy emphasis on language, the children being given the opportunity to

talk about the mathematics. Sometimes this talk would focus specifically on a mathematical resource. For example, in the following lesson the class are working with Debbie and a 100 square.

Debbie Now let's look at the number square, can anybody spot a pattern?

Naomi 1,1,1,1,1,(pointing to the tens in the teens row)

John 1,1,1,1,1... 2,2,2,2,2,... 9,9,9,9. (indicating the units in the vertical columns.)

Debbie Can you see what John means? He is saying that in the ones row there are all ones. What is your pattern Ruth?

Ruth It goes 1, 2, 3, 4, 5, 6, 7, 8, 9, (indicating tens in the 1 to 91 column.)

Debbie Does it do that in every row? (Column)

Ruth Yes

...

The 100square was used regularly in Debbie's classroom. In subsequent lessons the children would begin to use the square to solve single digit and then two digit addition and subtraction problems. Here, Debbie is focusing the children's attention on the structure of the resource itself, or in Lave and Wenger's terms, making the resource transparent. In later lessons, when learning to use the 100square to solve problems, the children already understood its structure and the relation between this and the place value system, and could more easily understand how to add on in tens and in units. The strategy became quickly internalised so that they could do without the 100square and calculate mentally. By making the resource transparent in this way, Debbie was enabling the children to understand not only what to do but also why. Children in one of the other classes in the same school, where this sort of discussion was not encouraged, found the 100square opaque and calculation with it just another procedure to be learned by rote. Furthermore, the procedure was dependent on the presence of the 100square, the structure of which was not internalised.

Mathematical Discourse

One whole class activity in Debbie's class centred around the number 7. Before the lesson Debbie talked to me about what she was going to do.

Some days we just look at a number and see how many different ways we can make sums that have that answer. Some of the children will just be able to do simple addition or subtraction, some might get into patterns. I hope that all the children will be able at least to try.

Debbie started the lesson by writing a large number 7 in the centre of the board.

Debbie Who can think of a way to make seven?

Rob Three and four.

At each suggestion Debbie wrote the calculation in symbols on left-hand side of the board (e.g. $3 + 4$).

Nozumo Four and three.

Ruth Seven and zero.

Lucia Twelve take away three ... er ... five.

Subtractions were recorded on the right-hand side of the board.

John Twenty take twelve.

Debbie Nearly

John Twenty take thirteen.

Nozumo Two add five.

Ellen Six and one.

Zeb Five and two.

John Twenty-one take fourteen.

Twenty-two take fifteen.

Ruth Twenty-three take away sixteen.

Ellen Twenty-four minus seventeen.

Nozumo One and six.

John Seven add seven take seven.

Ruth Twenty-five take away eighteen.

Twenty-six take away nineteen.

Beaty one add one add one add one add one add one add one, and 10 take away 3.

John Seven take seven add seven, eleven take four, twenty-seven take twenty

Beaty twenty-eight take away twenty one

Ruth eight take away one, twenty-nine take away twenty-two.

...

This is only part of a longer lesson in which the children all participated to construct a description of the number 7. Two key elements can be identified. First, the children were participating at their own level. Nozumo, Zeb and Rob (reception children) can be seen to concentrate on simple one step addition, while experiencing the subtraction and more complex multi-step calculations offered by the others. Secondly, the

children are building on each other's ideas. Nozumo (one of the newest reception children) seemed aware of commutativity, providing $4 + 3$ after Rob gave $3 + 4$, and later $1 + 6$ when $6 + 1$ was already on the board. Lucia introduces the idea of using subtraction; John takes this up and, after a false start, draws on the pattern created by pairs of number with a difference of 7. Ruth and Ellen can be seen to build on this pattern for themselves. So, the activity can be seen as taking part within a community of practice, jointly constructing a mathematical 'object' while building on their own and the knowledge of others. This joint activity has many of the features of a conversation - turn taking, listening to others, building on each others ideas. Along with the other 'conversations' seen in the previous classroom examples, we can see the specific discourse of the mathematics classroom developing. The children are learning to talk within the mathematics, offering their own insights to the rest of the class. Debbie, as the teacher, has chosen the task and developed the classroom ethos in order to enable this communal discourse. Later, when working in groups, the children would continue to discuss their work together, comparing and justifying answers. As a result, the teacher was not seen as the arbiter of truth but she encouraged the children to listen to one another and to reason for themselves, encouraging mathematical reasoning and exploratory talk, which Mercer defines as one of the distinguishing features of discourse in the classroom (1995).

Becoming: learning as identity

I found no incidents where children were ever told that they were wrong in Debbie's class. If an incorrect answer was given she would ask the children to consider it, "Do you agree with her?" and she would often indicate that it was not correct using the word 'nearly', which seemed to communicate to the children that they should self correct and they would often produce the correct answer, as we saw in the 'answer is 7' lesson. Mathematically, John's answer is wrong, twenty minus twelve is not seven. But Debbie seems to recognise that John has made a good attempt to widen the mathematical 'conversation' to include subtraction from larger numbers, and to say that it was wrong might discourage further attempts. From Debbie's response "nearly", John recognises that he has made a mistake, corrects his answer and then has the confidence to build on his corrected answer. Debbie and the children are building a class ethos where it is OK to 'have a go' and to make mistakes. The ethos has a positive effect on the children's attitudes and motivation in mathematics. As a result the children are wanting to become more able learners of mathematics, to attain mastery of the domain.

Summary

So, these brief examples show how Debbie and the children are building up a community of mathematics practice in the classroom. Even these young children are beginning to understand and use the activity, resources and discourse involved in learning mathematics. This is not to imply that Debbie was consciously applying social

practice theory in her teaching. But the theory can be used to show how her practice is encouraging a positive mathematics learning environment which others could emulate and offers a language with which to discuss the issues involved. In my wider study I found that although the children and teacher in primary schools are together throughout the day working on different areas of the curriculum, a particular mathematics community of practice existed in the classroom, with its own rules, its own physical and mental resources, its own discourse and its own practices. These elements were seldom explicit, were different across classes even within the same school, were different across different subject areas within the same class, and yet were a key part of the children's learning. Rather than there being a single community of practice in the primary classroom, multiple communities of local practice appear to exist. Further study of these practices could be useful to teachers and teacher trainers, adding to existing literature on effective teaching in primary schools (e.g. Askew et al. 1997; Pollard 1997).

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