DO THE STUDENTS LEARN THE TEACHER OR THE TEACHER LEARN THE STUDENTS? MAKING MEANING OUT OF DEVELOPING MATHEMATICAL CLASSROOM CULTURES

Laurinda Brown

University of Bristol, Graduate School of Education

In the academic year 1999/2000, the developing cultures of 4 year 7 mathematics classrooms were explored. Initially 4 teachers shared images of 'becoming a mathematician' with their students, particularly stressing 'asking and answering the question why'. Students were seen as entering a 'community of inquirers' within the scheme of work of their teacher's department. There is now a wealth of interviews, videotapes and observations from which to make meaning. Do Steinbring's (1999) descriptions of the autopoetic behaviour of mathematical communication offer a way of communicating an interpretation of what has happened over time in these classrooms? Rather than the students learning the teacher or the teacher learning the students there seems to be meaning making within the mathematics itself.

INTRODUCTION

Firstly, thank you to the participants in the presentation at the BSRLM Conference, Roehampton. The session was exploratory in that I now know that I still have some way to go before I have distilled the ideas of communication (Luhmann, 1996) and autopoiesis (Maturana and Varela, 1992, Luhmann, 1996, Steinbring, 1999) sufficiently to share a non-causal vision of the developing mathematical communication in the classrooms I work in. This paper shares my current thinking and attempts to identify the problems.

In the academic year 1999/2000 we completed the data collection phase of an ESRC funded research project 'Developing algebraic activity within a 'community of inquirers''[1]. The aims of this project are:

1. To create year 7 mathematics classroom cultures which provoke a need for algebra.
2. To investigate the similarities and differences developed in each of the teacher's classrooms. …
3. To develop theories and methodologies to describe the complex process of teaching and learning.

At the end of the data-collection phase, at the last full day meeting of the project team which comprises 4 teachers, one of whom is also a researcher on the project, and 3 other researchers, the 4 teachers were taped having a discussion prompted by the question: 'What will you take away with you?' The following comments from the transcript of that conversation have led us to seek ways of describing one similarity across the classrooms: the ways in which the students communicate mathematically rather than simply doing, or responding to, what the teacher wants:

Teacher C: Something that's similar, a few times at the start I've got them brainstorming what they know about something for themselves and then sharing ideas - you're not providing them with things, they're providing each other with it.

Teacher A: I think that opening exchange is just so vital because it just sets up the process ...

Teacher D: Or not ... And I wrote down something about discussion as well. I don't quite know what I meant about that, your 'strategies for avoiding answering the question' has felt very powerful in terms of scope for discussion …

Teacher A: I find they're so familiar and so at ease now with sitting listening when someone's talking or something, you just have to say 'hang on, so and so's talking' and they're all listening.

Teacher B: They've got a lot better about being willing to give their idea, not waiting until they know they've got a right answer.

Teacher C: No, there's no wrong answer is there.

Teacher B: No, just the willingness to share an idea.

Teacher A: … the thinking about the teacher being the 'fountain of all knowledge', coming to you for the answer whereas they can check with each other.

This discussion has developed out of the personal histories of these four teachers and their working together through meeting during the year of the research project.

There is something here about these teachers describing their students' discussions as being self-propelling. The students are not looking for whatever the right answer is from the teacher, nor do they worry about getting something wrong in front of their peers. Having observed mathematics lessons in these classrooms the students and teachers seem to face the same way, working on problems together. They seem to have entered a mathematical 'community of inquirers' (Shoenfeld, 1996). We need a language to describe these developing mathematical cultures which avoids the experimental sense of replicability; that if a particular decision is made early on it will necessarily be the case that other behaviours will follow. We are looking to describe the complex second-order systems of interactions.

AUTOPOETIC BEHAVIOUR OF MATHEMATICAL COMMUNICATION

How is it possible to describe the developing mathematical cultures within these classrooms? In 1999 I attended the International Group for the Psychology of Mathematics Education (PME) conference in Haifa, Israel. Having been introduced to the writings of Steinbring by a then master's student, currently a PhD student, Lolis Lozano, I went to his plenary lecture (Steinbring, 1999).

In the plenary Steinbring based his analyses of two classroom episodes on the ideas of Luhmann (1996) quoting:

> … when communication shall come about, … an autopoetic system has to be activiated, that is a social system, that reproduces communications by communications and makes nothing else but this (in Steinbring, 1999, p.42)

Autopoeisis is a term introduced by Maturana and Varela (1987) describing self-reproduction within biological systems. Here communication reproduces itself.

Having tried to read Luhmann's (1996) book 'Social Systems' in the English version I am, at the moment, content to try to explore this statement through the German Steinbring's translation from Luhmann's native language, German and will begin by describing the analysis of the two classroom episodes, from two different teachers, presented by Steinbring at PME. I recommend you to read the paper in full!

Autopoetic behaviour of the mathematical communication is destroyed

In the first episode the teacher's discourse can be described in the English context as 'guess what's in the teacher's mind'. The students effectively 'learn the teacher'. They do not communicate mathematically. Evidence for this is that the teacher acts as the fountain of knowledge with such comments as: "but it is not yet quite right" and: "Oh, he is very close" (Steinbring, 1999, p.52):

> In the course of the episode, the students are led to find out what, according to the teacher's opinion, is the only correct pattern (ibid. p.52).

For the communication to reproduce itself mathematically the students would have to be able to explore their interpretations independently of the teacher. The autopoetic behaviour of the *mathematical* communication is destroyed when the teacher confirms the answer is right because the students do not then continue their exploration of the mathematical ideas. The autopoeisis of the communication is 'learning the teacher', not being mathematical.

Autopoeisis of mathematical communication

In the second episode the students explore different proposed strategies to reconstruct a missing number:

> Instead of pushing ahead her own ideas, the teacher places the students' solution strategies into the foreground of the communication process, … for a given signifier there is no definite, fixed signified in communication, and therefore there is no unique universal sign, but different interactively evolving interpretations … participants have to develop their own different and multiple readings of the communicated sign (ibid. p.53).

There is no actual evidence of the teacher being present from the transcripts used in Steinbring's (1999) plenary lecture. The mathematical communication reproduces itself, flowing onwards as the students negotiate meaning in interaction and in contexts to create new knowledge for themselves. What is being constructed is separate from the teacher.

Is it possible to tell a story from the ESRC data-set supporting the autopoetic behaviour of the mathematical communication *not* being destroyed in these classrooms?

DEVELOPING MATHEMATICAL CLASSROOM CULTURES

The classroom cultures were developed through the teachers sharing with their students that the year was about them 'becoming mathematicians'. Schemes of work and organisational structures within the schools are different and it has not been our intention to change these. The content of the lessons has still to be decided by the teachers within those structures, but, during the day meetings there has been time to plan together, locating teaching strategies *e.g. beginning a lesson by offering two contrasting images for comment* which seem useful in starting lessons building on what the students know. Questions are raised by the teachers and the students through this process. At the start of the academic year the 4 teachers, A, B, C and D were interviewed about what being a mathematician meant to them on the principle that they would only see and comment on in their classrooms behaviours which they were aware of.

Evidence from Interview 1s:

Teacher A: So it means things like putting structure to the world. Trying to explain, … Order as in rules or logic, that sort of sense of order. Trying to clarify things. Seeing connections, … Explaining why things happen (8/9/99).

Teacher D: Or even I might even say that I must have a question that I'm thinking about almost to be mathematical. I am mathematical in relation to something ... some question that I have about this situation. … The question 'Why?' seems to be a very fruitful mathematical one (5/9/99).

All the teachers conveyed a sense of being mathematical being about asking and answering your own questions such as 'why?' or 'how?'. Are these awarenesses apparent in classroom practice?

Evidence from early observations of teaching

During the data-collection phase of the project I observed in three of the four teachers' classrooms. One of my filters when observing lessons was to write down what we call metacomments or the teacher commenting on behaviours rather than, say, delivering content.

By 21/9/99, observing in Teacher D's classroom, there is the following exchange:

Teacher D: 'What question were most people working on for their homework?'

Student: 'Why does it always come to 1089?'

Teacher D: 'There's a question before that (smiling).'

Student: 'How does it work?'

Student: 'I know, does it always work!'

Teacher D: ‘Two people have ones which didn’t.’

Through stressing the asking of questions, setting homework based on working on their own questions and using their homework to develop discussions at the start of the lesson, it is perhaps unsurprising that the students have already begun to ask the question ‘Why?’ for themselves. The teacher is running the discussion, but about a process, even though they are all actually working on a mathematical problem. As the year progresses the communication in the classroom becomes more student to student than mediated by the teacher.

By the end of October in Teacher A’s classroom there is a culture of the teacher asking questions e. g. ‘What do you notice?, ‘Why?’ and conjecturing. There is not evidence yet of the students asking their own questions:

Student: First is bigger than the fourth.

- Always?

Student: No.

- Why? Which one?

- I want you to give me a number to obey all those rules.

- 1 = 4 or 1 > 4.

- Before the bell goes let’s look at another column. Anything you notice about those 3 numbers? 3’s probably not a lot to build a conjecture around...

Teacher A, video transcript, 29/2/2000

At the BSRLM session at Roehampton we then looked at part of a transcript (which there is not the space to reproduce here) from a later lesson of Teacher A, looking for patterns in the communication in the classroom. The discussion focused around the use of ‘another one’ both by students and their teacher and the ways in which the communication is mathematical.

The culture has become established in which the pupils and teacher are used to discussing images from the students collected on the board. We have noticed, as a research group, when watching videos of Teacher A, that he often asks ‘Another one?’. Here it is Student 2 who uses the phrase "Sir, I've got another one". ‘Another one’ has a history behind it in this classroom and is used to indicate ‘another, different, one’. In some cases, where a pupil offers a 'different' one in their way of viewing the world, there might be a discussion and a decision to count this difference as the same (a x b is the same rectangle as b x a although the rectangles certainly look different. Classifying is a common activity in this classroom and questions arise both from the students and the teacher.

In this instance there is evidence of the teacher not only allowing the student strategies to be in the foreground of the communication process but also, at other times, making strategic decisions about where to focus the students’ attentions.

ISSUES ARISING

The conjecture here is that there is now some evidence of autopoeisis in the mathematical communication within Teacher A's classroom culture. The students are not 'learning the teacher' but equally Teacher A is present in the classroom and making complex, strategic decisions related to the flow of the mathematics which does not seem to destroy the autopoetic behaviour of the mathematical communication. These are not classrooms where the teachers learn their students without the capacity to make their own decisions from within the action. This seems to be a middle position illustrating teacher and students working mathematically together.

What seems powerful in terms of action is the separation for the learner of what is said from who says it. This does seem to make sense to me that with my PGCE students it is as though they have to unhook themselves from the (logical) presentation of the content to be interested in what the students are doing in response to the tasks they set before their classrooms become noticably more about learning. The function of the teachers on the project asking ‘why?' at the start of the year seems to have been similar, allowing a different sort of discussion to emerge in their students’ learning (end of project conversation above). But then, again, it all begins to sound causal. Do this and this will happen. Here the teachers are not simply being contingent upon their students, nor the students just ‘learning the teacher’, they are all involved in communicating mathematically. I would be very interested in your comments on all this and would be happy to let you have a copy of the transcript used at the meeting in Roehampton.

NOTES

1 ‘Developing algebraic activity in a ‘community of inquirers’’ Economic and Social Research Council (ESRC) project reference R000223044, Laurinda Brown, Rosamund Sutherland, Jan Winter, Alf Coles. Contact: Laurinda.Brown@bris.ac.uk or Laurinda Brown, University of Bristol, Graduate School of Education, 35 Berkeley Square, Bristol BS8 1JA, UK

REFERENCES

Luhmann, N.: 1996, *Social Systems*. Stanford: Stanford University Press.

Maturana, H. and Varela, F.: 1992, *Tree of Knowledge.* Shambhala Publications

Schoenfeld, A. H.: 1996, 'In fostering communities of inquiry, must it matter that the teacher knows the 'answer'?'. *For the Learning of Mathematics*, 16(2), 11-16.

Steinbring, H.: 1999, 'Reconstruction the mathematical in social discourse - aspects of an epistemology-based interaction research.' In O. Zaslavsky (ed.), *Proceedings of the 23rd conference of the International Group for the Psychology of Mathematics Education* Vol. 1 (pp. 40-55). Haifa: Technion, Israel Institute of Technology.