Snapshots from a classroom: an analysis of patterns of interaction over an academic year in one year 7 mathematics class

Alf Coles

University of Bristol, Graduate School of Education

This case study draws on data collected in one secondary mathematics department in the UK in the academic year 2007-8. I took six video recordings of Teacher A working with her year 7 class. In line with the enactivist methodology that informed the research, in this paper I look at the final recording of the year and trace the patterns that can be observed back through the rest of the data. The analysis of two patterns offers a partial lighting on how a particular way of working developed, and demonstrates how the patterns that can be seen at the end of the academic year are observable at the beginning of September.

Keywords: patterns of interaction, enactivism, linguistic ethnography

Introduction

The data from this case study comes from one secondary department in the UK. I took video recordings of lessons in the academic year 2007-8 in the classroom of Teacher A, who has regularly been appraised as 'outstanding' in terms of her approach to developing students' mathematical thinking skills. In this article I analyse the six recordings, four taken between 14th September '07 and 3rd October '07 the fifth on 30th January '08 and the sixth on 28th June '08 (I label these videos chronologically and refer to them as lesson 1 through 6). I took the video recordings as part of a Studentship study funded by the Economic and Social Research Council (ESRC); I was Head of department at the time. I wanted to explore the role of the teacher in establishing a classroom where students are able to be independent and creative in their work in mathematics; hence the high proportion of recordings from the beginning of the academic year, when I assumed classroom norms are established.

Enactivism and linguistic ethnography

I bring an enactivist stance to the research design and analysis of data (e.g., see Varela, Thomson and Rosch 1993, Reid 1996). While enactivism has its roots in a radical view of cognition, as a research methodology it also carries implications for the analysis of data. A key enactivist technique for analysis is to look at the end point, identify patterns and attempt to trace these patterns back through the data. The aim is not to make any statement of causality, but rather to trace the emergence of a feature that is recognisable by the end of the data collection. Gattegno (1987, 32) writes of the power of human intuition to offer different 'lightings' on the complex 'whole' of phenomena, and it is in this sense that tracing the development of particular patterns in a classroom offers a lighting on the development of the way of working as a whole.

My methodology is also influenced by the broad school of linguistic ethnography (e.g., see Rampton 2007). Linguistic ethnography draws on the literature of discourse analysis, for example Sinclair and Coulthard (1975) or Levinson (1979), in assuming that language in classrooms follows predictable patterns. I use Levinson's (1979) notion of 'activity-type' to denote 'socially constituted bounded events, with constraints on

participants, setting and so on' (p. 368) – constraints being needed for a pattern to be observable. Levinson also identifies 'episodes' (1979, p.369) within activities, giving the example of a seminar (an activity-type) that might be split into episodes of: introductions, presentation, discussion.

Data analysis

In analysing the video recording data, as stated above, I began with the final lesson (lesson 6). I initially segmented the recording into activity types (broadly distinguishing between periods of whole class discussion and individual, group or paired work) and selected only times of 'whole class discussion'. I then looked for transition points within whole class discussions to identify and mark episodes. I analysed the predominant patterns of interaction in each episode, for example there might be episodes that closely resemble the Initiation-Response-Feedback (IRF) pattern identified by several authors (e.g., see Sinclair and Coultard 1975, Mehan 1979 and Mercer 1995). An initiation is typically a question, or a turn in a dialogue that introduces a new issue that is not a response to, or evaluation of what has just been said. The issue of who initiates a sequence of interaction has become an important feature of my analysis, as I distinguish episodes where the teacher initiates and ones where a student initiates. Once I have identified episodes of interaction I look at patterns both within and across episodes, and patterns in the transition points. The patterns identified in lesson 6 were then used as a lighting on the rest of the data. I have chosen to follow through two patterns from lesson 6 in this paper, which were the first two patterns identified in lesson 6 when looking at the lesson chronologically.

Two features of lesson 6

The lesson begins with a series of sums for students to do; these sums were displayed on the board as the students entered the classroom and Teacher A instructed them to engage in this task as soon as they sat down. After time to work on the sums there was a brief discussion of the answers, and then Teacher A told the students to put their pens down and look at a new image she displayed on the board, which she had chosen as her starting point for an activity the department called 'Both Ways'.

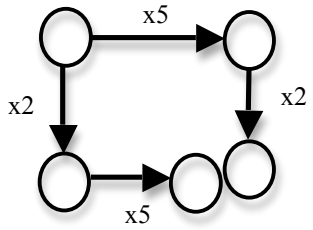

Figure 1: Teacher A's starting image for 'Both Ways'

There was a episode of interaction following the display of this image, in which Teacher A asked for a 'starting number' to go in the top left hand circle, and students worked out what numbers should go in the remaining circles by performing the operations indicated on the arrow. The two circles at the bottom right of the diagram end up with the same number, and at this point the pattern of Teacher A asking for responses was broken by the dialogue below. Teacher A wrote a number in the last circle, which was the same as the number she wrote in the neighbouring circle; she paused, looked at the numbers and said 'oh right okay'.

Transcription notation: … indicates some dialogue skipped; (.) is a pause of less than a second; (3) is a pause for the number of seconds in the brackets; *italics* indicate a voice that implies words said by someone else; (text)

indicates unclear speech and the best guess at transcription; ( ) indicates undecipherable speech; // // indicates overlapping speech.

TA oh right (.) okay

S yeah but why (.) why does it come to that

S is that meant to happen miss

S yeah

S no

S oh yeah miss

TA um (4) any comments (.) any comments

Many of the student comments were overlapping and I have not been able to capture anything like the range of statements that were made. The students here are raising questions about the mathematics.

Following Teacher A's request for any comments, I identify a new episode as the interaction pattern alters to one where students are offering ideas and agreeing or disagreeing with each other. A pattern across interactions in this episode is the use by students (three times in four minutes) of the word 'because', for example:

S the two answers in the little circles no matter what you start with will always be the same (.) because if you times five times two it's like times ten

There was no prompting by Teacher A for students to use a word such as 'because'; students spontaneously justify their ideas with reasons to help explain their thinking. A contrast to this pattern occurs later in the lesson, during a similar episode of students offering ideas and commenting on each others' ideas, this time in relation to a 'Both Ways' sum with x5 and +2 on the branches where the final answers are found to be eight apart. The students in this episode do not offer any explanations of their thinking, and Teacher A comments:

TA does anybody think they've got any reasoning they can do here as to why we're getting eight (4) any reasoning (.) why are times five add two and add two times five bigger and smaller (.) and particularly why are they eight apart

In the absence of students providing explanations of their thinking, Teacher A prompted it, with an explicit request for reasoning.

There are, of course, many more patterns observable within the final lesson but due to restrictions of space I will stick to tracing the emergence of the themes identified here, namely: students asking questions about the mathematics; students justifying their thinking without prompting; Teacher A prompting justification of students' thinking. The last two themes are clearly linked and I will trace their emergence together under the label 'student reasoning'.

Students initiating discussion of mathematics

In lesson 1 (students' second mathematics lesson of the year, and hence their second mathematics lesson in secondary school) there is the following interaction:

S1 could I say what I was going to say about number 2

TA I'd love you to say (what you were going to say on number 2)

This is the first instance in the recording of a student initiating a sequence of interaction and also the first instance of a student asking a question. In watching the video recording with Teacher A, she remembered having an individual conversation with this student, during a paired work episode of the lesson just before this interaction, in which the

student had told her an idea, and Teacher A had replied 'that's the kind of thing you might want to raise when we are talking as a whole group'. The pattern of whole class interaction shifts following this statement, with students continuing to take an initiating role. The discussion about the issue raised by S1 takes up the majority of the whole class discussion time in lesson 1, at the end of which students are told to work in pairs or individually on issues raised by the discussion by Teacher A saying:

> TA right (.) I want you to now (.) write down the conjecture you're going to work on … I put there things that you can do (2) so try lots of different examples (.) can you disprove the conjecture … (.) can you prove it … (.) can you give reasons to back up your opinion (.) … I'd like you to work on the conjecture you want to work on

The first instance, in lesson 2, of a student making an initiating comment is:

> S2 if 'a' is only one bigger than 'c' then the answer will always be 99

As in lesson 1 there is an extended period of whole class discussion centred around this statement from S2 at the end of which students are invited to work in pairs or individually in a similar manner to lesson 1.

Also, in lesson 3 there is a student-initiated comment:

> S1 you know (the ones on the board) I've got another one (.) one two three four (.) and I turned it around and I couldn't do it

Discussion focused on this point until the following interaction:

> S4 it's not about that
>
> TA yeah go on
>
> S4 at the end of last time it's a conjecture that I had
>
> TA yes
>
> S4 if the first and last digit are different by one

As in the first two lessons, discussion continues of S4's conjecture until Teacher A invites the class to continue work on these ideas in pairs or on their own. This pattern is not evident in lesson 4, in which Teacher A offers a proof related to work they have been doing, and their task is to attempt to reproduce the proof.

In lesson 5 students are working on finding ways of calculating the areas of polygons. There is, again, the same pattern of a student initiated comment being discussed for a prolonged period, leading to Teacher A setting the class individual or paired work, linked to the discussion. In this lesson a student comments:

> S3 wouldn't it be easier to just split it up into four

There is discussion of this idea until this interaction:

> S4 with the rhombus or kite whatever one we were doing //TA: yeah// you could um cut it in half and then one the sides you get a little box and it's like half of the […]
>
> TA do you want me to cut it towards in half or across
>
> S4 um downwards (.) and then (.) then you could like draw a little box and then half of that so it would be easier […]

This students' idea is discussed for a further ten minutes, with six other students offering ideas and suggestions, before Teacher A closes off that episode of the lesson and gets students working in pairs on issues raised in the discussion.

The pattern, in four of the first five video recordings, is striking – it seems as though Teacher A is waiting for a student initiated comment, to then be able to discuss it and draw out the questions, tasks or issues for students to continue work in pairs or on their own. Given

how student contributions are seemingly so valued, and central in directing discussions and the work that ensues, I find myself unsurprised that all six of Teacher A's students that I spoke to in interview in 2008 commented on how much they enjoyed and felt they learnt from class discussion.

Student reasoning

In lesson 1, following the student comment 'could I say what I was going to say about number 2', which was reported above, the next five student comments are as follows – I have edited out the content and left the structure of what was said:

S5 you don't necessarily have to …

S6 … on that one if no one never … all the answers would be …

S6 so (.) it doesn't really matter what number it is so long as …

S7 … I reckon you should actually … because …

S8 no (.) because …

In the second lesson of the year (lesson 1) there is evidence of students justifying their thinking (e.g., in the use of 'because'), as in lesson 6 without prompting from the teacher.

In lesson 2 the first mention of explanations or reasons comes from Teacher A after 40 minutes (of the sixty minute lesson):

> TA … what I'm impressed with is firstly those of you trying to explain their conjectures (.) so I had similar discussions going round (.) *I can't prove it it's always working*… if you're going to prove something … try every single number … or try explaining why something works (.) okay try and prove it (.) why does it always work … not got enough time to try every single three digit number what we can do is we can try and put our thoughts together and try and come up with some convincing explanations (.)

Following this comment three different students offer explanations of their conjectures.

Lessons 3 and 4 both have times where the explicit focus of discussion is on proof; Teacher A demonstrates an algebraic proof, linked to conjectures the students had been making both at the end of lesson 3 and start of lesson 4. In both instances students are invited to try and recreate the proof in pairs, and then extend it to try and prove different conjectures that had been developed in previous lessons.

In lesson 5 the students' task is to find rules for calculating the areas of different types of quadrilateral and there are several comments suggesting methods:

S3 times the length by the width

S5 on the trapezium you should really make it into a rectangle

Although the focus at the board is on particular instances of, for example, a trapezium, I interpret students in the comments above as sharing their reasoning for why areas of such shapes in general can be calculated in particular ways.

Emerging themes

The pattern of Teacher A running class discussions is that she continues until a student takes the role of initiator and asks a question or offers an idea, which is then the basis for prolonged debate until either a different student initiates another idea, or Teacher A judges that the class are at a point when they can work on the ideas of conjectures that have been raised. This pattern only became apparent to me through the enactivist technique of analysing the final piece of data and tracing back themes.

The fact that in lesson 1 students are heard using 'because' and offering explanations of their thinking implies that these students came to secondary school equipped with the skills to do this kind of reasoning. Many discussions of skills such as 'reasoning', for example in the literature on metacognition, take a deficit model where it is assumed that students need educating in certain metacognitive skills or knowledge (e.g., see Veenman et al 2006). In the study reported here, some students exhibit unprompted reasoning skills at the beginning and end of the academic year suggesting that Teacher A's expertise may not have been so much in teaching students this skill, but in providing contexts for them to exercise a skill at least some of them already had. Of course the situation is not simple and the evidence from the data is also that Teacher A has an on-going focus with this class of prompting and supporting their reasoning, for example in offering students a proof in lessons 3 and 4.

In this paper I have reported on two of the many patterns that are evident in Lesson 6 (e.g., another is talk of 'conjectures'). I am struck by the complexity of the overlapping themes and threads that can be traced through these six hours of video recordings, and how, so far, every pattern observable at the end of the academic year can be traced back to the very beginning of September. The converse does not appear to be true – i.e., with a different teacher in the department whose lessons I also video recorded, there are some patterns observable in lesson 1 not evident from then on. Hence it may not be possible to tell from a first lesson what patterns will become the significant ones that persist; but it does appear that patterns that survive are established early. Hence this study supports the intuition that the early meetings with a class of students are critical for establishing norms and expectations of participation.

References

Gattegno, C. 1987. The Science of Education. Part 1: Theoretical Considerations. New York: Educational Solutions.

Levinson, S. 1979. Activity types and language. Linguistics 17:365-399.

Mehan, H. 1979. Learning lessons: Social organization in the classroom. Cambridge, MA: Harvard University Press.

Mercer, N. 1995. The guided construction of knowledge: Talk amongst teachers and learners. Clevedon, UK: Multilingual Matters Ltd.

Rampton, B. 2007. Neo-Hymesian linguistic ethnography in the United Kingdom. Journal of Sociolinguistics 11 (5):584-607.

Reid, D. 1996. Enactivism as a methodology. In Proceedings of the Twentieth Annual Conference of the International Group for the Psychology of Mathematics Education. Valencia.

Sinclair, J., and M. Coulthard. 1975. Towards an analysis of discourse. Oxford: Oxford University Press.

Varela, F., E. Thompson, and E. Rosch. 1991. The embodied mind: cognitive science and human experience. Massachusetts: The MIT Press.

Veenman, M., B. Van Hout-Wolters, and P. Afflerbach. 2006. Metacognition and learning: conceptual and methodological considerations. Metacognition and Learning 1 (1):3-14