Researching as a mathematics teacher educator: analysing mathematics teachers' detailed descriptions of first lessons

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As a mathematics teacher educator, researching classroom environments and practices has supported me in linking theory and practice so that awarenesses developed support the prospective teachers with whom I work. The research has built a belief that there is not one way to teach mathematics. How do experienced mathematics teachers create the environment in which they teach? What do they consistently do from their first lessons with a group? This paper reports on interviews with effective teachers of mathematics in the UK where they stay with the detail of what happened in recent first lessons with a group new to them to illuminate their decision-making processes as they establish the culture of their classrooms. Energetic statements arising out of the detail, such as "I like to give things a story" can be used to support novice prospective teachers, like with Alf Coles, to find the teacher they can be when faced with not knowing what to do when teaching their first lessons.

Keywords: Mathematics teacher educator research, classroom environment, interviewing.

Background

Over my career as a mathematics teacher educator (MTE), I have interviewed many experienced teachers of mathematics. As I accepted the post of lecturer in mathematics education, in 1990, I left the classroom and my then role as a curriculum developer. I became fascinated by the mathematics teaching of others that seemed so different from my own. This paper explores stories from experienced mathematics teachers related to the detail, elicited using an interview, of their first lessons with a new group of students, investigating the questions: How do experienced mathematics teachers create the environment in which they teach? and What do they consistently do from their first lessons with a group? The first set of interviews explored the first lessons of experienced teachers because my prospective teachers did not have access to these and did not know what to do in their own first lessons. They may have had ideals of what they wanted to be as a teacher, with a view of what a classroom in which learning mathematics takes place might be like, but they did not have the experience to have honed the skills that would allow this vision to exist.

I have continued to interview practising teachers as part of my research to extend my awarenesses of possible practices, rather than come to some fixed view of what mathematics teaching looks like. Over time, my interviewing practices have changed and these interviewing practices have also influenced my practice as an MTE. In what follows, I will first discuss my interviewing practices and how these link to my practices as an MTE and will then move on to discuss cases of interviews.

On interviewing

The original "first lesson" interviews were designed using Bruner's (1990) ideas of a "culturally sensitive psychology":

> [which] is and must be based not only upon what people actually do but what they say they do […] how curious that there are so few studies that [ask]: how does what one does reveal what one thinks and believes. (pp. 16–17)

I will be reporting on what the teachers actually do and what they each say they do in their mathematics teaching to illuminate their decision making in the next section. It was the access to the decision making that was supportive of the developing prospective teachers because I had a range of anecdotes available in group and individual discussions in those early days. However, as my interviewing skills developed, especially through Claire Petitmengin's writing and protocol, the process of interviewing became part of the structures of the course.

First lesson interviews

First lessons with a new group of students were important to teachers in establishing their ways of working, but were often times where observers of the lessons were not so welcome. This included having a video-recorder in the classroom because it might cause a distraction in an important lesson or sequence of lessons. As a new mathematics teacher educator, I was fascinated by observing different mathematics teachers and their students interacting. The nearest I could come to observing first lessons was to interview teachers as soon after the lesson as possible.

At the time, I designed an interview protocol where each teacher interviewed was invited to tell me in detail about a first lesson or sequence of lessons with a group of students who had not been taught by them before. I wanted to focus on what happened in some detail as the teacher established their ways of working with the class. In looking at the transcripts again, I was struck by how similar my current interviewing protocol is and was moved to listen again to the tape-recordings (having found a player!) listening this time for when each teacher's voice was more energetic. This energetic voice was heard at times when they were talking *about* the detail, seeming to discover meaning in what they had been doing. The first-lesson interviews were an important critical incident in my own development as a mathematics teacher educator. I started to listen for energetic comments from my prospective teachers, as evidence of their learning, articulations of what previously had been implicit.

Claire Petitmengin's interview protocol

The protocol for interviewing I currently use is adapted from the work of Petitmengin (2006) and has strong similarities with those early interviews. Petitmengin designed the protocol for her doctoral study, related to supporting epileptics to identify internal changes prior to having a fit. The design of the study linked the third-person neuroscience that had shown the changes in mappings of the brain, with a phenomenological first-person protocol redesigned as a second-person interview. The behaviours for the interviewer were the focus of Petitmengin's protocol and are as follows:

> *Stabilising attention*. A regular reformulation by the interviewer of what the subject has said, asking for a recheck of accuracy (often in response to a digression or judgement). Asking a question that brings the attention back to the experience, such as, "How did you do that?"
>
> *Turning attention from "what" to "how"* (never "why").

> *Moving from a general representation to a singular experience*, a re-enactment, reliving the past as if it were present. Talking out of their experience, not from their beliefs or judgements of what happened, often involves a move to the present tense. Staying with the detail is important, a maximal exhaustivity of description that allows access to the implicit. (adapted from pp. 239–240)

One of the changes in my own behaviour as an interviewer over the years has been to let go of "why" questions, whilst still supporting interviewees "talking out of their experience, not from their beliefs or judgements" (Petitmengin) to focus on "what people actually do [and] say they do" (Bruner). The changes in my behaviour as interviewer also led to changes in my behaviour as MTE. There was a realisation that the actions in the protocol were useful for supporting any learning, which could be described as "access to the implicit". So, using these strategies could support the prospective teachers in supporting the learning of the students in their classrooms, getting them to talk through what they were doing when stuck on a problem say, and asking for evidence or examples when faced with an assertion. I developed an activity under the label of "diagnostic questioning" for prospective teachers to listen in pairs to each other solve a mathematical problem whilst the "interviewer" used strategies to draw out the other rather then get involved in the mathematics themselves. Over time, Alf Coles and I, who were colleagues teaching the prospective teachers together, extended the protocol for what we call narrative interviewing to a fourth point:

> *Getting to new category labels*. After dwelling in the detail, telling stories and exploring without judgement or digressions, invite statements of what is being worked on. In this way, new category labels might be identified […] that will link to learning new actions. (adapted from Brown & Coles, 2018, p. 178)

The prospective teachers need to act in the classroom even when they have no experience to draw on. In a small group, led by one of the MTEs acting as facilitator, the prospective teachers are asked to think of a story when they were feeling uncomfortable in their recent classroom experience. One person tells their story, without judgements or digressions, minimally and this is followed by others in the group telling stories that seem similar to them in some way (see The Mathematical Association, 1991, working group chaired by Barbara Jaworski). At some point, a discussion about what is similar about the stories happens and these statements might be different for different students. This discussion might give a range of "new category labels", for example, "How do I know what they know?"; "How do I know that they know?" that can be worked on by those prospective students who find them meaningful by trying out a range of actions in their classrooms that can be used flexibly to support the classroom environment. In this way, developing my skills as an interviewer impinged directly on my practice as an MTE.

Cases from the original first-lesson interviews

The teachers (10 in all from which I will illustrate two) were chosen by the three local advisory mathematics teachers who had observed them in their classrooms as being particularly effective (deliberately not defined because I wanted a range). The teachers were encouraged to stay with the detail of their first lesson with a new group of students and, in so doing, they also commented *about* the detail, without being prompted to by me. This might mean comments about their images of

teaching and learning mathematics or about what mathematics was to them. These comments were said energetically, often quickly and explosively. In Petitmengin's terms, I would now read these comments as giving "access to the implicit". In listening back to the original tape-recordings, for analysis, I paid attention to these energetic comments.

Case 1: "I like to give things a story"

One teacher in his first lesson with a new group described using the following problem:

> I had a dream last night and, in that dream, this is what I heard. You must build a tower and from the top of the tower, sort of like a plus sign from the side, it should look like two staircases meeting. We haven't decided yet how big the tower should be but when we decide, you must be able to build it and organise the building of it.

After telling the problem, the following exchange occurred where there was a shift in the teacher's comments to be *about* what he had described, giving access to his thinking and beliefs:

> Teacher: I like to give things a story because I like to give the children a natural language as a parallel to the mathematical language.
>
> Laurinda: So, a story for you would apply basic language, not mathematical language. Any other things that you would say in the story?
>
> Teacher: I think it allows enabling people to enter the world of maths you are talking about then if you have got a story if it's amusing or catchy in any way they might get interested in the first place, but it does provide short simple language with which they can converse with one another. So, it allows for group work which is something else I think.

In this extract, my contribution is stabilising attention, repeating back what I have heard said and returning the focus to the story, to the detail of what happened. This comment is followed by the teacher saying more *about* the thinking behind his decisions, giving insight into his vision of how the lesson will develop, what will be done over a sequence of lessons before returning to the detail of what happened:

> By the end of two days' work we were going to have posters of this and I wanted the posters to be different and I wanted people to have things to look at which would be new for them and interesting, and I wanted different people to have different problems that they would be solving [...] just to show that a huge range of possibilities can come out of story anyway. There is not one right answer, there are lots of answers […] I then asked them in groups again, individually, to write down the task and everything and the story and then in groups giving them five minutes to do that, in their groups to decide what kind of questions or concerns or worries the architect has.

Thoughts on Case 1

The word "story" is part of a rich set of interconnected images for this teacher. There are reasons such as using natural language alongside the mathematical language and also criteria for choosing a story, given that the children will do different things so that the children can see a "huge range of

possibilities" emerging. Story is also linked to metacomments, where the students are asked to review each other's design and come up with questions for the architect. The element of role play makes the learning student-centred, in that they have to make decisions. The teacher sets up the environment of the classroom and comments on the students' actions, whilst the students themselves are given the responsibility of doing the mathematics. Mathematics teaching and learning being about story is closely linked to this teachers' and their students' behaviours.

Case 2: "Mathematics is a study of pattern"

The teacher begins the mathematical part of his first lesson with:

> So, on the board I write mathematics is a study of pattern. Basically, in a sentence I would say it is and then I draw little arrows and say there are two basic big areas of maths, one is numbers and the other is shape. I give them all this philosophical stuff. Today we are going to do an activity that is going to combine between these two things.

Quite soon after the description of what happened above, the teacher energetically, talking about what he does, revealing his passion, says:

> What I find with children is they all think that maths is just numbers […] I always try to emphasise how the two areas really do link because I think apart from anything else, anybody using the creative side of their brain, geometry can help a lot in understanding power in the numbers […] bad experience with number work seems to block their whole mathematical enjoyment and I try to emphasise that maths is lots of things and not just knowing your times tables.

The teacher is clear what he wants students to be doing sitting them in groups to work together:

> Well I'm looking for the children to be confident enough to be able to take an original idea and then move it on themselves into different areas.

Thoughts on Case 2

The teacher in Case 2 sees mathematics as pattern, linking to a passion for overcoming students' previous bad experience with number. All his interactions with students supported this. The problem, given to students first, is one that he has used before, many times and has confidence in. Initially, the teacher reports that, when asked what mathematics is at the start of the lesson, no-one responds, whereas, twenty minutes in to exploring a problem, that links number and shape, students are describing patterns and asking questions. The teacher is able to comment, about their work, to students that they are doing mathematics.

What follows is a report of using the interview protocol over four years, with the same teacher, Alf Coles, initially new to the profession, showing how the interviews change over time.

Alf Coles's first-lesson interviews

I first started working with Alf Coles in 1995. In the early days of working with him, he was a new teacher and I interviewed him at the beginning of his second year of teaching. I will use the first-

lesson interview of 1995 to give some background to where the fourth protocol item developed and discuss differences with the interviews with experienced teachers.

Getting to new category labels

When I first met Alf, he was in his first year of teaching and did not have the experience to link his teaching practice with his beliefs. The protocol of asking for details of his first lessons gave us an opportunity to see what underpinned his practice. There seemed, however, to be no energetic comments *about* his teaching occurring within the interview linked to what he does as a teacher. The following interchange from 1995 shows how Alf is finding some actions that support his ideal image of teaching mathematics as opposed to actually being able to achieve that ideal in his practice:

AC: With my year 9 class who I had in year 8 one of the things that I said to them at the beginning is that one of my aims this year is to try to make you independent thinkers, although who knows what independent means. That felt quite nice because I could come back to that.

LB: That was in a first lesson?

AC: Yes. That gave some power to when they said, "Can you tell us how to do this?" that I could say, "I'm wanting you to do this independently."

Compared to how the teachers in the original first-lesson interviews talk about their teaching, in the 1995 interview, when reliving the first lessons with a new year 7 (11–12 years old) group, there were no comments from Alf about the details of his teaching and no energetic comments. It was in our conversation after the interview, when I reported back to him about this, that the comment above about the year 9 (13–14 years old) group emerged. This was an energised statement and evidence, to me, that he had begun his journey to be able to act in a way consonant with his beliefs. The interview was at the start of our work together and also developed into a conversation about what we might work on and what it was I was interested in. Some of my comments were linked to what he was saying. My comment, out of my experience of other first lesson interviews, was a response to Alf talking about his vision of teaching mathematics:

AC: A sense of what it's like to create a space for students to work on their own images. A sense of how that could be maintained. Picking up from what students have said at the beginning of class […] by some people giving their method or explaining what they're doing it's not that you're taking away the journey from the others it's helping them along.

LB: [A] description of you at the moment is that you have no metacommenting. Some teachers when they are teaching are metacommenting. Some people think of this as patter - [...] "remember to reflect on what you're doing as well as do it." […] I don't think I've spotted any. [I]t's not good or bad. I think what happens to [experienced] teachers is that they become very clear about what they're trying to do, so all those metacomments become completely standardised and in a sense they become close to their behaviours - it's a sort of autopilot. Right down to a [child] comes

> up and says, “I’ve got a problem with this” gets a reply, “OK, you tell me.” It’s a metacomment because it’s saying, “I’m not going to engage with this until you tell me.”

As we continued to work together, each year I did another first-lesson interview at the start of a new academic year until, by 1999, a pattern had become established and the interviews were similar, with similar comments about what was happening. At this point, we wrote up our research in a book (Brown & Coles, 2008). The 1999 interview illustrates the way in which the interview shows what Alf did and what he said he did. Alf states, near the start of the lesson,

> AC: And I said welcome to mathematics at secondary school. [A]s well as all the skills and techniques like adding or multiplying or taking away that they will have learnt and they will continue to learn it’s also about learning to become a mathematician […] and learning to think mathematically […] [I]f you’re thinking mathematically then it’s about noticing things about what’s around you and it’s about writing things down about what you notice […] a question about something […] maybe they’ve seen a pattern and a question that mathematicians often ask is “Why?” Make a prediction maybe based on that pattern. Say why they think that pattern will continue.

This purpose of the year “about learning to become a mathematician”, was linked to behaviours for the students like asking questions and making predictions. There were also metacomments about the students’ ways of working that Alf made, such as, “That’s a really nice example of how working together mathematically as a group that in talking about how you’re doing something you can recognise where you’ve gone wrong.” These comments are not pre-planned. In the complex decision-making, moment-by-moment in his classroom, Alf’s comments about what his teaching is about are underpinned by metacomments close to his and his students’ behaviours in doing mathematics.

In working with Alf for the last twenty years, we have come to see staying with the detail, dwelling in it, as a mechanism for finding the images of teaching, new category labels, that can be linked closely to actions as teaching strategies emerge that support students. This is particularly important for working with prospective teachers of mathematics, who are in the position that Alf was in in 1995. Ideals, such as independence or autonomy, of what they want to be as a teacher, are not linked with a view of what a classroom in which learning mathematics like that might take place, nor to teaching strategies. They simply do not have the experience to have honed the skills that would allow this vision to exist.

Novice and expert teachers can learn in the same way, staying with the detail of what happens and dwelling in it, what Varela (1999) calls “deliberate analysis”,

> Indeed, even the beginner can use this sort of deliberate analysis to acquire sufficient intelligent awareness to […] become an expert. (p. 32)

For an expert teacher, this could be creating a new label linked to a behaviour to solve an issue arising in their classroom. Intelligent awareness “allows experts to unpick, if necessary, the reasons

an action was taken, and hence open themselves up to alternative possibilities in the future" (Brown & Coles, 2011, p. 862). This again, for us, is Petitmengin's "access to the implicit", bringing to conscious attention the behaviours that support the ideal images of teaching to be put into practice.

The first-lesson interviews with experienced teachers were not designed to change what the teachers were doing. These teachers were experienced and effective according to local mathematics advisory teachers. I was interested in how they did what they did.

Conclusions

So, how do experienced mathematics teachers create the environment in which they teach? From their first lessons, they are able to comment to students about their behaviours, for example, "you're doing mathematics" (Case 2) and give them activities related to their beliefs about what mathematics is, such as the story problem (Case 1). In cases 1 and 2, the teachers use problems they have confidence in to achieve their clear images of what their classrooms can look like with their students, "describing patterns and asking questions" (Case 2) or "different people having different problems they would be solving" (Case 1). What do they consistently do from their first lessons with a group? What does seem to be the case is that for all these teachers their beliefs are closely linked to their and their students' actions in their mathematics classrooms. Their different beliefs lead to different actions but, through the teachers metacommenting about actions they see as fitting their image of their mathematics classroom, the students know how to do mathematics in this teacher's classroom. Even though the practices vary with the images of mathematics and mathematics teaching and learning of the students, what seems important is the students knowing what to do. Prospective teachers, similarly to Alf Coles, can use this same process of staying with the detail to raise new possibilities for action. Paying attention to the variety of practices that could lead to effective mathematics teaching and learning supported my own development as an MTE, in that I came to see my role as not replicating my own classroom practices. As an MTE I gained conviction in there not being one way to teach or learn mathematics.

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