Using Videotapes in Classroom Research to See Anew

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Videotapes can store a comprehensive data bank that can be revisited many times and examined through different lenses. This paper outlines how videotapes are being used a PhD project, and tells how data were revisited as new theories developed. The taped data supported the development of new levels of understanding about interactions in mathematics classrooms as well as about processes of interpretive educational research.

Videotaping Classrooms

Videotaping is used in classroom research in two main ways. First, videotapes are used to stimulate recall by teachers and students, in order to provoke participants to reflect on and talk about their interpretations of experience. Researchers and their subjects view selected snippets of tape, or perhaps watch whole tapes with either person able to stop the tape at any point (e.g. Marland, 1994). Free association can be used (e.g. Hsi & Hoadley, 1994), but more commonly the researcher asks probing questions (e.g. Argyris & Schön, 1974; Barnett, 1991; Hoyles, Armstrong, Scott-Hodgetts, & Taylor, 1984; Owens, 1996). Interpretations by researchers can be triangulated (see McFee, 1992) or even developed in conjunction with classroom participants. While this "stimulated recall" is a feature of my PhD methodology, it is an aspect of video use that I will discuss in other papers.

Another common use of videotapes is to capture classroom interaction, to enable its close analysis by a researcher in isolation. Here, videotapes have some advantages over field notes in their detail—they hold audio images, complete with pauses, inflections, volume, and relevant background noises. They also hold more complex data that audiotapes because they record teachers' and students' physical gestures, facial expressions and movement around the teaching area. The data can be revisited many times in order to be examined through different lenses or for various purposes. This revisiting, as it has become part of my PhD project, is the focus of this paper.

Methodology

The PhD project is entitled *Teachers' constructions of their roles in building mathematical understanding*. Specifically, the focus of my attention is on what teachers think mathematical understanding is and what they do to develop it. Four case studies of teachers' work are being developed. The teachers are from one school: two have Year 6 classes and two teach Year 2. In this school, two teachers look after each grade level, and they generally plan their work together. Starting with the *Curriculum & Standards Framework* (BOS, 1995) and the school's pre-determined "themes" that are used to integrate subject areas, pairs of teachers outline a work program for the whole year. This involves arranging concepts and skills into what seems to be a logical order, taking account of what the children have been taught. The teachers then work together in planning specific learning activities. Worksheet and test preparation is shared by taking turns.

Pairs of teachers sharing preparation, aiming to teach the same content through the same activities, and then using the same assessment instruments, provides a useful context for studying how individual teachers in similar positions construct their roles differently. While the intended curriculum and planning are common for many lessons, the implemented and realised curricula are somewhat different for many reasons—so that is one aspect of my analysis.

Videotapes in Use

This paper will focus on data gathered from the two Year 6 teachers, "Russ" and "Jill". I videotaped as many of their mathematics lessons as I could attend over a period of ten weeks. Whenever possible, after taping a lesson I interviewed the teacher about what s/he wanted children to understand by the end of the lesson, how s/he had tried to develop that understanding, which children in particular had understood well or not understood the concept(s), and how the teacher knew this. Periodically, semi-structured interviews were used to explore the teachers' backgrounds, as well as their beliefs about such factors as group work, assessment, parental expectations, and so on. The focus of these longer interviews is on how different elements of the pedagogical environment seem to support or constrain teaching for understanding. All interviews were audiotaped and transcribed.

Initial data analysis involved categorising field notes, snippets of videotape and interview transcripts. The initial categories used were drawn from an initial review of early literature on "Understanding" (e.g. Dilthey, 1927; Heidegger, c.1926; Hume, 1748) and from current literature on understanding in mathematics education in general (e.g. Bastick, 1993; Mevarech, 1995; Skemp, 1992) and of children's understanding of particular mathematical concepts (e.g. Pitkethly, 1994; Truran, 1994)

The videotapes of each lesson were compressed to digital format (see Mousley, Sullivan and Mousley, 1994, for a brief outline of this process). They were then watched several times to identify pertinent pedagogical incidents that seemed to fit the pre-determined categories. When necessary, new "emergent categories" (Glaser & Strauss, 1967) were formed, to accommodate the behaviours observed in the videoed lessons as well as the actions that the teachers claimed they use to develop understanding. Each snippet of video that seemed relevant was entered into a spreadsheet, along with a code summarising its origins, start and stop frame numbers, and a short descriptor to aid future recall (and assist in computer searching for particular incidents, questions, etc.)

Figure 1 shows data from the beginning of one spreadsheet. (As this paper is not being read from a computer monitor, you will need to imagine the video symbol to be interactive, in that when it is clicked the relevant video snippet plays.) Also noted on the spreadsheets were details that I wished to follow up with the teacher during later interviews.

Code	Teaching action	Start	Stop	Details
131.01	Stimulating recall	36	60	"With our work on endangered species ..."
131.02	Eliciting children's explanations	60	150	(Various children, until Brad mentions "scale"). * PRE-DECIDED CONCEPT PRIVILEGES RESPONSE. * OTHER PURPOSES OF THIS TYPE OF INTRO?
131.03	Using b/board	100	170	Writes scale of model car, to illustrate Brad's example.
131.04	Emphasising language	90	201	Repeats, stresses terms: *Scale*, *Compare*
131.05	Use of example			"I was just saying ... no comparison for whale size."
131.06	Using aid	165	201	"On that chart ..."
131.07	Accepting un-invited example	210	260	Ryan (inaudible - do audio - scale used in mapping) * SEEMS TO UNDERSTAND IN CONNECTED WAY -- IS THIS TYPICAL OF RYAN?
131.08	Stimulating recall	210	260	"When we did our map reading ..." (Picked up Ryan's context. Look at effect of other uninvited examples, whether used.)
131.09	Eliciting children's explanations	210	260	"How did you work it out in km?" Using scale to calculate length --Essence of the lesson.
131.10	Child's explanation	260	340	Stacey: Clear articulation of her understanding (Idea of ratio)
131.11	Stimulating recall	340	349	Do you remember what the scale we had was? * DID NOT PICK UP STACEY'S RATIO (RELATIONSHIP) IDEA? WHY?

Figure 1. A sample of coded snippets: *Teacher 1 (R), topic 3 (Scale, lesson 1)*

A similar process was used to categorise the audiotapes, typed-up observation and interview notes, and scanned versions of the worksheets used in the observed classes. The spreadsheet software's capability for sorting was then used to group data which had been classified in particular ways, and this sorted data was used to form indices to structure a multimedia framework.

Using the scripting program *Authorware Professional* (Macromedia, 1995), an interactive program was constructed so that categories and several levels of sub-categories of data can now be recalled and viewed, read or listened to with ease. For instance, clicking on the "Explaining" menu (see Figure 2), allows me to access (through menus and sub-menus) all categorised examples of teachers' and children's explanations, the teachers' actions which promote explanations, and any interview comments or field notes that seemed to be related to explanation.

4. EXPLAINING

Claims about explaining
- Importance of
- Constraints to

Explaining strategies
- Verbal explication
- Using gestures
- Using diagrams or drawings
- Using aids
- Using recall, drawing on previous experience
- Using examples
  - Giving examples
  - Accepting uninvited examples
  - Eliciting examples

Eliciting children's explanations
- Questioning
- Prompting/provoking
- Inviting

Clarifying
- Providing clarification
- Seeking clarification
- Eliciting further information

Explaining activity
- Giving initial directions
- Explaining directions further
- Re-explaining directions

Figure 2. Working category 4: Explanation (at 2/2/1997)

My aim is not merely to describe observable behaviour, but to attempt the more difficult task of understanding action, which (as Wiseman, 1990, notes) includes the *intentions* of behaviour. I am conscious of many levels of subjectivity of this work, such as how the teachers themselves interpret their teaching actions, my re-interpretation of these, and the obscurities associated with terms such as "mathematics" and understanding". I am well aware that no matter how many times I revisit the data, only those actions, comments and events that I have paid conscious attention during the lesson will form part of my final framework. Such are the limitations and complexities of interpretive research.

The video and transcript snippets are often overlapping and multi-dimensional, i.e. applicable to several categories. The categorisation is temporary and transitory—this work is in preliminary stages and there are huge gaps and overlaps in the data as well as the analysis process. Each time I revisit the data in the light of recent reading, reflection, or subsequent data, the framework develops further and requires some reorganisation.

The videotapes have not only helped structure the framework to date by facilitating close examination of the action, but have also supported the development of theories that are "grounded in the data" (Glaser & Strauss, 1967). Being able to revisit the video data (as well as to arrange further interviews with the teachers, see Mousley 1996) has assisted in the development of my understandings, as it has enabled me to "see anew" (Mason, in press). The following is intended to give the reader some sense of how this activity has progressed.

Developing Different Types of Understanding

Water in the Bath is a popular lesson from the Mathematics Curriculum & Teaching Project (Lovitt & Clarke, 1988). I videotaped this lesson, during which groups of children had acted out a scene to give physical expression to the shape of a particular line graph drawn on a worksheet. I instigated the usual interview after the lesson.

Judy	What understandings did you want the children to develop during this lesson?
Jill	Graphing the level of the water. Reading the graph ... the axes. I thought it was a good lesson for the video. We all like hamming it up. I thought it would be a change for you. Different from children doing maths in their seats.
Judy	It was great fun. Entertaining ... nice variety for the children. What was it you wanted them to understand about graphing?
Jill	Just the axes. That the line shows change. How the line represents the water level.
Judy	They seemed to understand that well, I think. It is difficult because when the line goes up the water goes down.
Jill	Yes. I had expected some confusion. My demonstration at the start gave them the idea, I think.
Judy	Yes. Do you think they understood the idea of the rate of change in the water level?
Jill	(no response)
Judy	The steepness of the line?
Jill	Yes. Some did.
Judy	How did you know?
Jill	K and P ... their stories were spot on... and I was surprised at M and L.
Judy	Can you tell me more about that. What do you mean by "spot on"?

Lesson 261(Int)

The patterns of response here is very typical of that demonstrated in the post-lesson interviews with both teachers. Initially, "understanding" was taken to be understanding of the task, with emphasis on the physical processes involved (acting out graphs, drawing scale models, completing percentage or probability exercises, etc.).

Similarly, the teachers spontaneously suggested the simpler concepts that were involved (that the line shows changing water levels, that one whale is x times as long as another one, that percentage is an expression of a quantity out of a hundred, etc.) More complex mathematical understandings took more probing, and in many cases teachers responded to this questioning by naming children who had understood particular ideas. There was not one lesson where the teachers felt that the more difficult ideas were understood by all children.

This ordering of priorities was also evident in the videos—by far the greatest number of explanations, for instance, was focused on explaining tasks; followed by actions aimed at developing simpler mathematical concepts. The teachers' claims about individual children's levels of understanding were generally supported by the data, with higher-level concepts being developed in individual and small-group situations. Thus initial video analysis enabled me to link the teacher's actions (intentions, behaviours) with their perceptions of the lessons and their claims about what had been understood by their pupils.

Revisiting the Classroom Interaction

After taping about ten lessons, I became aware that the Year 6 teachers had been trying to develop the children's understanding of ratio in almost every new lesson during the observation period. These lessons included three on scale (the basic idea, scale drawing and models, scaling up and down); two on rates (e.g. $/kilo, km/hr); one on rate of change (*Water in the Bath*); and one on probability. It struck me that these ideas were being introduced as quite separate skills and knowledge strands, but the underlying concept (ratio) was not attended to explicitly during any of these lessons. There were also other uses of rational number in mathematics lessons, such as reducing fractions to lowest terms in the "mental maths" exercises completed at the beginning of each lesson.

Having the ability to review and reanalyse the videotapes became invaluable at this point. Again, I appreciated the multidimensionality of the data collected, with its gestures, drawings, emphases and pauses—as well as the way the movement of teachers at different stages of the lessons, the record of which comments were directed to particular students, etc. This detail enabled my re-examination of the classroom interaction with a very different agenda—it made possible my "seeing anew".

New questions arose along this new avenue of inquiry. Had teachers made links that I had not seen? Was there evidence of children making connections between the various concepts? Was any teachers' or children's language used (or patterns of language use) the same or similar across the development of the concepts?

Such questions led me into a new level of analysis, but also to a broader field of inquiry and theory building—with a new range of questions. Do teachers (more generally) see links between the topics that had been taught? Does the format of national, state an school curriculum documents mitigate against teachers and children developing these connections? How do pre-service teacher education, professional development, and common assessment practices prevent or support the recognition and use of key mathematical ideas which underlie the school mathematics curriculum?

I realised that my questioning about relational understanding (Skemp, 1976) had not been probing enough. It had focused on the lesson content, but not the teachers' own understandings and the reasons for the ways that they think about separate topics and skills. For instance, I had several snippets of interview data such as the following:

Jill — I tried this year to do percentage first and go over the ideas several times before I really hop into probability and things like that, because if the children really have a solid understanding of percentage, hopefully it will be easier to use that understanding when it comes to interpretation of the stats, and probability, and things like that.

Judy — Do you think it is necessary for the children to see how those concepts are linked?

Jill — Yes, but if you do it that way you wouldn't get the learning outcomes done ... you just can't do that and cover the necessary work.

Judy — I noticed that you talked first about percentages being out of a hundred, and then you took fractions like six tenths being sixty out of one hundred, and started talking about equivalent fractions, and simplifying fractions or else making them up to hundredths. Do you think the children understood the links?

Jill — No. I think the hundredths one they do. They understand that link—percentages being hundredths. But it is obvious that we need to go back and spend a lot more time linking vulgar fractions through to hundredths, through to percentages. So that is something we need to go back to do more work on. They were fine when it came to using calculators to work it out. That wasn't a problem, but that doesn't need much understanding. But we have run out of time. This is just a start, though—they will pick up percentages again in Year Seven, and Eight, and probably Nine.

Lesson 282 (Int)

Judy Do you see these two percentage lessons growing out of any of the work you have done in the last few weeks.

Russ Well, fractions. They have to see a percentage as a part of a hundred. That's why we start with hundreds squares and they color them in.

Judy Yes. That's really useful for modelling percentages. But then it is a big jump from colouring in hundredths to, say, converting three-fifths into a percentage.

Russ Well, they have done equivalent fractions before. It is important to use that knowledge. Some will get it—like B; but others like S won't. We have done them [equivalent fractions] in the mental maths sessions. You just have to hope they will make the links. You could spend a lot of time getting them to see how one works like the other, but you don't have the time to do that all the time. And even if you did, people like S would never get it. It is best just to teach her processes—even then she forgets them.

Lesson 182 (Int)

Conclusion

Luckily, I had arranged for my interviews to become extended "conversations" with these teachers, so I can probe further when I return to the school. I will also be using the categorised videotape snippets, along with discussion points noted during the analysis period, to have the teachers talk more about specific aspects of their work.

It is clear that videotaping can be a valuable tool in mathematics education research. For me, it has given new meaning to Skemp's term "relational understanding", in three ways. First, it raised questions about key concepts in early mathematics learning and how these could be used in the development of teachers' and children's understandings about the links between mathematical topics. Second, it made me wonder about aspects of teachers' lives that support or limit their conceptualisation and use of these ideas. Third, it made me realise that what we come to understand during the research process can move from the instrumental to the relational—and that videotape analysis can support this transition.

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