

# **Ethnographic Research in Mathematics Education: Using Different Types of Visual Data Refined from Videotapes**

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Some ethnomethodological research techniques that can be used to analyse social activity in mathematics classrooms are examined. A method where sections of video-audio tapes were transcribed to facilitate detailed inquiry, and individual "photographs" were used to reproduce some of the data not available in transcriptions, is described. Snippets of the original data were also available in movie format. This paper outlines some of the advantages and limitations of each of these three forms of visual data, and raises issues of anonymity and subjectivity.

## *Introduction*

The use of video technology in mathematics education research is well established. It is used as a tool to capture classroom action, from which examples of activity type can be identified and discussed (see for instance, Barnett, 1991; Frid, 1994; Frid & Malone, 1993). Research data in video format is also integrated with other data in various ways (see Clarke & Kessel, 1995; Lambdin, Duffy, & Moore, 1995; Maher, Pantozzi, & Martino, 1996). It also enables events in mathematics classrooms to be used to stimulate recall of events (Owens, 1990). At the 1997 MERGA conference, I reported on how video is being used in a current research project to capture classroom interaction and to enable its close analysis (see Mousley, 1997). I noted that videotapes have some advantages over field notes and audiotapes, especially because they enable the rich and complex data to be revisited many times in order to be examined through different lenses and for various purposes.

This paper focuses on my later use of the videotapes, when snippets of video that were judged to be potentially useful were converted to two extra forms of visual data: transcripts and photographs. The paper provides a brief report of the processes used and then undertakes a comparison of the three different forms of visual data.

## *Conversion Processes*

Videos of classrooms all share one characteristic—they offer us a wealth of detail. However, while opening up opportunities for thorough analysis of classroom events, the very richness of the data presents a problem. Spindler & Spindler (1992) articulate this well:

No one can sit in a classroom and take notes on more than a very few of the things that come to one's attention simultaneously, and questions always arise as to why one's attention was focused in a given direction and not others. But the problem with much of what collects using [video] recording is that these data are so complex and inclusive that one has, in effect, to do the field work over again in order to analyse the material thus collected. (p. 77)

Converting video data to other formats can be a useful part of this revisiting process, in that each of the linked formats (audio only, video only, photo frames, and transcripts) serves to contain a researcher's focus and hence encourages reflection on a more limited field of activity.

After the original videotapes were digitised and compressed, the data existed as documents on a hard disc; each one a digitised "movie" of a full lesson. Using pre-determined and emerging categories, each snippet of video that seemed relevant to the research question and its literature was indexed according to the event type and entered into a spreadsheet. That is a link to it was pasted in to the sheet, just as one would paste a graphic into a word document; and clicking on its icon plays the relevant snippet. For

each snippet I also typed a note on its origins, a note on its categorisation, and a short descriptor (see Mousley, 1997). During this process, and as my analysis progressed, possible uses for different sections were noted in a "diary" column on the spreadsheet, along with questions to ask the teachers in further interviews, items that seemed to relate to points arising from the literature review or to other data, the need to seek further examples and non-examples of the event types, and so on.

To date, through this process, many sections of the lessons have been subjected to close examination in relation to "mathematical understanding", the topic of my thesis. One step in this analysis involved transcribing that section of the tape, for reasons outlined below. Another was to convert selected frames from the videotape to "photographs". The process used here involved (a) choosing suitable frames, (b) saving them as freeze-frame images, (c) opening them using a graphic software program, (d) adjusting the photos' contrast, size, etc. to clarify the images and focus on the important action, and (d) saving them in a format that allowed them to be pasted into relevant sections of the thesis and appendices.

### *Transcription*

The chief reason for transcribing sections of the data was that PhD theses are still generally expected to be print documents that are examined in hard-copy format and then become part of a shelved library collection. The regulations that exist in most universities (expected length, presentation, etc.) do not even recognise the possibility of alternate forms of presentation for the thesis itself, although performance and exegesis are accepted as conjunct forms of presentation, and audiotapes are now more commonly accepted as appendices. Thus it was necessary to have examples of classroom interaction that could fit within this traditional format.

The second reason for transcribing pertinent sections of the video-audio tapes was to provide a basis for close analysis of the data. The transcription process, while tedious, has proved invaluable. It has brought aside comments, difficult to interpret responses, and other features that one does not generally focus on as part of an aural experience into a form that has promoted more careful analysis and reflection. For instance, as I typed a child's response to a teacher's question, my mind would wander to possible meanings that the child could have held and may have been trying to express. Did the boy who said almost inaudibly that, "Half an hour is sixty minutes" make a simple mistake and really have the necessary knowledge, or was he thinking ahead in the problem to the fact that it required the use of minutes from more than one half hour (two hours, in fact), or did he really believe what he had claimed? On first viewing of the lesson (through the lens of the video camera), and even on re-viewing the tape, the action I was watching was so fast and so complex that I did not have time for such considerations, and in fact I am not sure that I even heard his claim. However, the act of and pace of transcription (or perhaps the tedium of transcription) gave me the opportunity to remark on such comments, and prompted me look back and forward to other parts of the lesson for evidence of the meaning that that child held. This also led to a closer analysis of how the teacher appeared to assume one specific meaning and how this assumption affected the way she dealt with his comment at a later stage of the lesson.

In general, I have found that transcriptions are useful in that they take away visual distracters, such as the movements and gestures of the classroom participants, and thus they enable a focus on the spoken word. The transcription facilitated my noting of the use of particular words, phrases and patterns of speech. For example, each time a teacher talked about a "group of one" I could note the child or children's responses and gradual development of understanding. Patterns of speech were used to help step a child from a know fact to a challenge, such as "A week is seven days—and a fortnight?". Patterns of interaction were used for more subtle teaching purposes were also evident, such as each time when one teacher needed a correct answer so that she could use the child to help explain how it was obtained she called on one particular student.

The transcriptions are proving very useful in my discussions with the teachers. In practical terms, they have enabled me to give the teachers a section of the lesson well before an interview, so that they have time to look at and think about it—perhaps in the light of a question that I have also given them, or perhaps just as a section that might lead to a productive conversation.

They have also proved an easily navigable and searchable resources for re-visiting sections of the lesson. I had assumed that videotapes would be used for “simulated recall” and some of that process has been used, but organising to use transcripts has been much simpler, because the video room does not have to be booked to show a representation of a lesson snippet (perhaps a ten-second incident). Similarly, a contained section of a transcript (perhaps only a few sentences) can be handed to a teacher and become the focus of conversation, without distractions of preceding and subsequent interactions. Because the lesson transcript was in print format, it could more easily be presented alongside data drawn from other sources. For example, I was able to pull out all of the interactions a teacher had with a child to do with the development of a particular maths concept mathematics across a few lessons, and print them on the same page as a relevant section from an interview with the teacher.

However, some of the very factors that make oral language a rich data source were stripped out in the transcription process, including gesture, facial expression, bodily presence, and pauses (including the pedagogical tool of “wait time”). Similarly, where a child sat in a group, and the physical interactions between children (such as two children quietly talking together while the teacher was explaining a concept) were also no longer part of the available data. Cazden (1988) and Gee (1990) note that analysis processes much take account of the fact that texts are part of social situations that comprise of more than language. I found that the more contained a data form, the more difficult it proved to posit as the meaning of a text and to claim adequate evidence for any particular conclusion.

### *Photographs*

My use of photographs within the thesis has several aims. The main one was to recapture some of the raw data that had been stripped out, as noted above, and to do this in a form that could be presented in the body and the appendices of the printed thesis. While a short quotation from the text can convey some meaning, a photograph can enrich this remarkably. For instance, when a transcript line reads “It’s thirteen!”, aspects such as the expression on a child’s face of whether (s)he has a hand raised may be important features of the dialogue that have been lost. Thus the use of still frames from the video allowed some representation, in a printed record, of the physical activity that was part of the classroom activity.

Like the transcripts, the photographs allowed selection from the complexity of the interactions and this enabled me to focus on particular incidents and small aspects of the interaction in my later deliberations. With the use of cropping, aspects of the frame that seemed particularly relevant to the topic at hand could be foregrounded. As Erickson and Wilson (1982) note, “Having one’s visual ... attention directed one way or another is an intrinsic part of the experience of viewing and editing documents” (p. 6). Also as with the transcripts, photographs allowed time for deliberation: an image that stays in view for as long as it takes to talk about an aspect of it facilitates interpretation of the image by teachers and researchers as well as interpretation by the researcher of the meanings the teacher holds. The time afforded gave me opportunities to reduce dependence on premature and audio-dominated interpretations.

Still photographs also allowed for events in the background to be noted. In one frame, I noticed a child taking her shoe off during a game of Buzz. The teacher wanted the group to learn to count by twos, but when the child was put out of the game (that is, by chance she was number ten) she had “tuned out”. Even though I had watched the video many times, I had focused only on the engaged pupils and the strategies that the teacher was using to build their understanding. Noticing the background information in

that photograph took me back to the videos of the Buzz game and other activities where the same child was filmed to see whether she was ever engaged when not centrally involved in the discourse, and to compare her patterns of engagement with those of other children who did seem to develop the desired mathematical understandings and skills.

As Henry (1991) noted, when teachers watch a video, they tend to get “caught up” in the complexities of classroom interaction. Walker and Alderman (1972) claim that “the continuously moving image (on film or videotape) encourages the audience to identify with the actions (while) stop-frame ... sequences retain more strongly their identity as visual representations” (p. 136). I found that reflections on their own looks, clothing, expressions, vocal tenor, etc., or on aspects of the videoed interaction such as the activities of a wayward child, easily distracted teachers’ attention from the focus of the interview, and that this was less likely to happen when a series of photographs was used.

As a researcher, using photographs (and later playing or fast-forwarding the tape with the sound turned off) took my attention away from vocal interactions enough to consider other aspects. Shifts in physical arrangements for participation signalled subtle shifts in social participation (termed *f-formations* by Kendon, 1990). “ownership” of a new idea, for instance, was very different in group and individual situations. Conversely, teachers’ expectations for different patterns of social engagement led to children arranging themselves physically. When, for example, a teacher said, “I want you to record your own ideas and solution”, children moved apart and used their bodies to shield their work, taking up a very different physical formation (and using a different idea of what it is to do mathematics) that they did when the teacher had indicated expectations for group problem solving.

However, photographs do not facilitate the study of connected sequences of physical actions, give a sense of time, link the visual with the aural, or cater for the development or cause-effect theories. Why does a child put out twelve counters as a group of ten and two ones, as requested, and then sit on them? Why does a child spend ten minutes drawing a clock when a quick sketch would have enabled him to work on the mathematics of the problem? Why does the teacher smile and nod (as if giving positive feedback) as she corrects the child’s misconception? How is it that after repeated explanations, the child does still not seem to understand the notion of rotational symmetry? What is the meaning a boy’s head-nodding as he watches a teacher’s demonstration, then continues to use a completely different algorithm—and what effects did his nods have on the teacher’s shaping of the explanation?

In comparison with videotape, photographs also suffer from the same lack of wider context as transcripts. The audience responds to the information it has by trying to fill in missing details in order to make sense of the data. Just as we create viable stories from comic strips and works of art, we interpret data by trying to make it fit with a known social system. The more data we have, and the more varied that data, the more we are likely to be able to create a story that creates a viable fit with the original event.

### *Ethical and Subjectivity Issues*

With transcripts, it can be relatively easy to hide the identity of teachers, children and schools, although some useful critiques have been written on this position (see, for instance, Richardson, 1973). With photographs and videos, however, the task is near impossible. Some techniques are available: I have spent many hours blurring the figure of one child whose parents did not give permission for her to be filmed, but even this action draws attention to her unseen presence more than the use of a pseudonym in the relevant transcripts does. Of course most teachers, children and parents willingly give permission, but the point raised at MERGA in 1996 is an important one: What happens if a naive ten-year-old later becomes an important person and the video is then used for unethical purposes. This is not likely to be a problem if raw video data are used only in the analysis stage of research projects, but when they are made available within the thesis and its appendices, these are publicly available documents.

It has been a particularly difficult aspect of the project to write up events in ways that do not leave the teachers open to unfair comparison and criticism. Films of two teachers teaching the “same” lesson content inevitable set up a comparative situation, even if no comments are written to this end. Similarly, snippets of teachers who ignore a child for a long time or appear to be particularly demanding of a child (perhaps for a legitimate reason that observers cannot access), and excerpts of teachers giving muddled explanations that are always easy for an observer to replace with a more coherent statement, are further examples of the types of video data that lay teachers open to criticism. While the inclusion of such problematic material can be the subject of negotiation between researchers and their subjects, it is difficult to have such discussions without the participants’ values—related to being a teacher (with public perception, promotion and personal-professional pride at stake) and being a researcher (with useful data at stake), as well as the traditional teacher-researcher hierarchy, presenting barriers to true negotiation.

Just as conversion to transcripts or photographs does not overcome ethical and moral problems that arise when videotapes are used to research mathematics classrooms, it does not assist one to make valid judgements as a researcher. Data gathering and presentation in all three visual forms outlined above raise problems to do with subjectivity. The first is inherent in conscious and unconscious decision-making about what is to be captured on video: camera operators attend to what captures their interest. While I started out with every intention of following a teacher, because I was interested in the roles that teachers play in developing children’s mathematical understandings, this decision in itself posed dilemmas. For instance, there was much that happened as a consequence of an interaction with a teacher that I felt needed to be captured. For example, what a child wrote after an interaction with the teacher might demonstrate a growth of understanding arising from that interaction. But a focus on the child’s writing would take the lens off the teacher, despite the fact that the next teaching event was in progress. As noted by Erickson (1991), although film records are relatively complete documents, they can never be complete, and decisions about what to record and how to record it are not neutral.

Also, paradoxically, what teachers do not do is as much a part of the teacher’s activity in a classroom as what the teacher does. A child who obviously does not understand the mathematics problem that is being worked on and who is ignored for a lengthy time may be considered to be an important component of the interaction, and a vital aspect of the teachers’ work that needs to be recorded. When one is using a video camera to follow a teacher, decisions then have to be made about how to gather evidence of incidents such as this.

The selection of classroom events for representation, analysis and writing up is a value-laden exercise. I have been aware of this when making judgements about which lessons seemed most productive for explorations related to the project’s research question, given that only limited space (and bytes) will be available in the final products. Is it better to search for concise snippets or to use longer ones that illustrate more clearly the point being made? Similarly, I have been conscious that selection of certain sections of lessons, and then particular snippets to transcribe has been a subjective process—and have found that talking and then writing about this proved more cathartic than helpful.

The most obviously uncomfortable research act in relation to the three visual formats for data presentation was the selection of video frames to convert to photos. For instance, in the time that it takes to say “What do you mean by ‘equals’?”, one frame shows a teacher leaning towards a child and looking interested, while in another she is backing off and looking into what appears to be the distance while appearing to be quite disinterested. The transcript implies interest, and the video shows that she has been temporarily distracted by another child but immediately re-engages in the conversation. However, a single photograph indicates neither. A series of photographs would, but then that virtually re-forms that section of the video.

A similar situation is faced when one has to decide how to frame a photograph. It makes sense to keep a video shot as wide as possible, because “the concern will be with

the limits and boundaries of attention rather than with their forms” (Walker & Alderman, 1975). When writing up a project and selecting appropriate photographs, it makes sense to frame the action so that it brings pertinent areas of the picture closer. This situation is little different from the selection of any data to support arguments being made by researchers. (Which incidents?, Which sentences?) However, I was more conscious of the potential effects when choosing parts of a photograph to be included or cropped. The enforced choice of frame, together with later choices about how much of the frame to include, raises questions about what story (in a post-structuralist sense) I, as a researcher, want to have represented by the photograph. Perhaps I wish to convey the message that continual interruptions in busy classrooms make it impossible to give enough attention to each child’s cognitive and verbal functions, or that teachers value classroom control above the development of individuals’ understandings, or that expert teachers can use a quick gaze with subtle characteristics such as raised eyebrows or pursed lips without interrupting a productive mathematical dialogue. It is not a matter of my presenting some objective truth—there would probably be elements of each of the above in this incident, but in any case I have no way of knowing their relative influences. There would also be other stories that I have not even considered, or stories (such as genuine disinterest by the teacher) that I may have thought about and dismissed because of my other experiences in the case study site. It is also not a matter of asking the teacher what she was thinking at this time, for we are not aware of many of the movements we make as professionals, let alone the reasons for them; and even if she were aware, the response would be likely to be affected by the research context.

Selection of any data is subjective, and the greater the reduction (the more that the result is decontextualised over area and time), the greater is the potential for biased choice. What needs to be recognised is that with any medium the selection processes themselves must be the subject of discussion. In relation to the use of photographs as research data, Walker (1985) notes that this can bring strength to the project:

Photographs, ... long unused in observational research because of the problems of subjectivity and bias associated with the taking and processing of pictures, provides a more acceptable stimulus once selectivity becomes part of the subject of the research. ... A slight shift in angle, the inclusion of exclusion of contextual information, the choice of one split-second rather than another provide similar pictures open to very different interpretations. This weakness of the photograph as data can be turned to a strength when it is used to elicit responses or to communicate complex messages. ... part of the task may be to replay events to the people involved to get them thinking and talking reflectively ... What is important about the picture is determined, in part at least, by what people say about it. (p. 143)

### *Conclusion*

Videotapes on mathematics classrooms, however used, provide limited data. Ethnographic research involves analysis of particular recorded events “in relation to the broader circumstances of choice and constraint within which the event occurs” (Erickson, 1992) so microanalysis of audio-video needs to occur in the light of other data about the broader personal, institutional and socio-cultural circumstances, networks and discourses of the research context. The research methods that I have outlined above do not provide this broader context—but they have assisted with the data analysis process.

Recognising its limitations in ethnographic research, in comparison with other tools, what videotape does capture is relatively complete. A wealth of information is available for description and interpretation. We can use this resource as it is, we can link it to other available data, or we can enrich its use by employing its various aural and video components. I have attempted to outline the advantages of using three individual visual products derived from the filming process, suggesting that they allow deliberative and

focused attention on various aspects of the classroom interactions. However, I recognise that such research processes are not unproblematic, and that the resulting formats do not overcome many of the dangers inherent in the use of videotapes in mathematics education research.

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