

VIDEOTAPES AND MATHEMATICS LEARNING: METHODOLOGICAL AND TECHNICAL ISSUES

HELEN J. FORGASZ, JULIE LANDVOGT, GILAH C. LEDER
 School of Graduate Studies
 Faculty of Education
 Monash University, Clayton

Videotaped records can have distinct benefits over other methods of data collection. The technique also has limitations and frustration can be encountered in its use. Inherent in its apparent simplicity is the temptation to use the medium inappropriately. Judicious consideration of the research question and related methodological and technical issues will determine whether videotape is the suitable choice. In this paper we describe three quite different mathematics learning situations in which videotaped records were used. Common to the three situations was the recognition that no other data collection technique would provide the information sought as effectively. Both visual and auditory information were essential. Yet in each case the researchers were faced with a unique set of interacting difficulties before, during and after videotaping. Our discussion also outlines some consequences associated with using and retaining videotaped information.

Videotape is an intuitively appealing means to collect observational data. The medium has distinct benefits over other research techniques. The most obvious advantage of having primary data in this form is that it can be reviewed and re-examined repeatedly and extensively (Adams, 1971; Mehan, 1979). However, the limitations of videotape and its vulnerability to inappropriate application are often not appreciated or discussed. In this paper we present some methodological considerations associated with the use of videotape and examine three different mathematics research projects in which videotape was utilised. Technical and other allied difficulties are highlighted.

A characteristic of most forms of qualitative research is an emphasis on conducting studies in 'natural settings'. Often participant observation is included amongst the methods of data collection (Jacob, 1988). Field notes are the most common means by which ethnographers record data. However, several factors can influence the selection of the most appropriate method. The choice "depends very much on one's purpose, the nature of the setting, and the financial resources available" (Hammersley & Atkinson, 1983, p.145). Audiovisual techniques can "provide a much more accurate and detailed account of events than can be provided in notes" (Hammersley & Atkinson, 1983, p.157). In particular, if the researcher is looking at the detail of both verbal and non-verbal interpersonal interactions, "electronic recording is probably essential" (Hammersley & Atkinson, 1983, p.157). Videotape should be seen as supplementing and not replacing the participant observer taking field notes (Hammersley & Atkinson, 1983) since "much of the additional information available to the on-site observer is lost" (Hamilton & Delamont, 1974, p.9).

Videotape can also be used in studies based in more systematic observational paradigms. When a range of methods for coding observational data were compared, Kieren and Munro (1985) found that the on-site coding method produced less than 50% of the number of units recorded from methods based on videotape records. The categories into which the data were coded were also found to be the most discrepant. In a review of a classroom study where student-teacher interactions were analysed from videotaped records, Hart (1992) commented:

Particularly, the use of videotapes allowed for a more detailed view of teacher-student interaction and clearer evidence of reliability than has been possible in many previous studies using systematic observation. (p.81)

The use of videotapes has enabled the merging of two research paradigms: process-product and sociolinguistic (Peterson et al., 1984). The analyses within each paradigm suggested relevant and important implications for research in the other.

Financial considerations may determine whether videotape is a feasible alternative for recording information. Analysis of videotape can be very tedious and time consuming. Adams (1971) reported that "on an average, each hour of classroom tape was subjected to twenty hours of analysis" (p.107). Kieren and Munro (1985) found that producing transcripts from videotapes which involved three people interacting took a minimum of two and a half hours for ten minutes of videotape.

In classroom settings, technical limitations such as the type and sensitivity of the microphone and camera, and their positioning, can restrict the sound and picture quality of recordings. Students 'performing' to the camera, background noise, the narrow view through the camera lens, and visual obstructions can be biasing aspects of using videotape. There are also associated ethical issues. Videotape is an intrusive medium producing permanent records. Confidentiality of names, faces, and school uniforms can be maintained in written reports emanating from videotape analysis, but not from the video records themselves. Participation and permissions associated with research projects involving videotape may also be more difficult to obtain. Consent for student involvement may not be granted or, if approved, may be coupled with considerable restrictions.

STUDY OF SMALL GROUP WORK

Developing positive attitudes towards mathematics has increasingly been viewed as an important aim of mathematics education. According to Schoenfeld (1992), new methodologies were needed in research associated with the affective domain to integrate meaningfully perspectives on cognition and affect in mathematics learning. Kiesler, Collins and Miller (1969) contended that:

Social scientists have, almost without exception, settled on pencil and paper or interview techniques for the measurement of attitudes while retaining a theory that specifies behavioral implications for attitudes (Kiesler et al., 1969, p.23).

As early as 1934, Lapiere (1967/1934) found a mismatch in the relationship between attitude and intended versus overt behaviour. Studying humans behaving in relevant contextual settings is one way to develop a better understanding of "the relationship between feelings and inner expressions on the one hand and observable behaviour on the other" (Eiser, 1987, p.3).

In this study of five year 7 students working co-operatively on a group mathematical task, the aim was to examine the interaction of students' cognitive engagement in the task and their attitudes towards mathematics and themselves as learners of the subject.

Some data on students' attitudes were gathered using more traditional pencil-and-paper means. The affective variables of interest were derived from a number of models put forward to explain gender differences in mathematics learning (see Leder & Forgasz, 1992). Students completed a number of instruments and responded to items in both closed and more open formats. These data were regarded as providing measures of students' beliefs and as indicators of intended behaviour. Of interest, however, was the study of actual behaviour in a relevant contextual setting, engagement in a mathematical task. Affective behaviours could then also be compared with the pencil-and-paper indicators.

In order to infer students' attitudes and their cognitive engagement from what they said and from what they did, it was important to capture clearly all verbal interactions between the students as well as to have an unobstructed view of each student at work. Videotaping the students was considered the best means by which the aims of the project could be met. Field notes were kept to supplement the videotaped records. Since the camera and microphone were focused on the activities of the group, there were times, for example, when group members moved around the room out of camera view and instances when the teacher spoke to the class and was not clearly audible on the tape. In these situations, the advantages of having the participant observer were clear.

It was recognised that the close proximity of the camera and the placement of the 'floor microphone' in the centre of the cluster of tables on which the students worked were factors which might constrain and inhibit the

'normal' flow of conversations and the pattern of work. This called for early familiarisation with the presence of the camera in the classroom. Several weeks prior to the small group work, the camera was brought into the classroom. For two lessons the tape was not switched on. By the third lesson the class' curiosity had been alleviated and 'performing to the camera' had virtually ceased. When the time came to film the small group at work later in the year, "camera shyness" was quickly overcome. The mathematical task set also stimulated the group's interest and the students set about tackling it enthusiastically. Some of the verbal exchanges picked up on tape indicated that they seemed to have forgotten that their words and actions were being recorded!

Videotape analyses of the lessons proceeded at several levels: an overview of the students' behaviours over the whole sequence of eight lessons, individual lesson summaries, and fine-grained analyses of critical episodes within lessons for which transcripts were central. The transcription phase was extremely labour-intensive and took an inordinate amount of time; approximately three minutes of videotape were transcribed per hour. Yet the data obtained were rich and most informative. To describe the students' affective behaviours, operational definitions had been developed which used transcript excerpts to illustrate the variables under investigation. The details of the operational definitions and analyses have been reported elsewhere (Leder & Forgasz, 1992).

Whilst the school, the teacher and the students had been most co-operative and enthusiastic throughout the conduct of the study, permission was not given for short videotaped excerpts to be used to illustrate aspects of the findings and share them with the wider educational research community.

WORKING WITH SINGLE STUDENTS

Monitoring student learning in a regular classroom setting and exploring the implications of the data obtained were the main goals of the second study to be described. The sample comprised students in grade 3. Selected mathematics lessons which contained substantial oral explanation segments were videotaped. The earlier general comments about the advantages and disadvantages of this method of data gathering and transcription of the material, are also pertinent to this study.

As described in more detail elsewhere (Leder, 1990a; 1990b), key components of the lesson were selected for replay and discussion with students in a one-to-one setting in a quiet room available for this purpose. A structured interview format was used to probe student interpretations of teacher explanations and their apparent understanding of the work covered. In this more intimate and relaxed setting students' beliefs and practices could be explored in greater depth than is often possible in a whole-class environment where questions need to be addressed to a larger group.

The interviews, and the examples students were encouraged to attempt during them, confirmed that students had been engaged in the work, had listened to the teacher, and that they had learnt from the lesson. However, their interpretations were often at variance with those intended by the teacher through her carefully sequenced series of steps that seemed most appropriate within *her* cognitive framework. Creative adjustments were made by some students in their struggle to make the teacher's explanations consistent with *their* conceptual framework. For example, reasons for students' confusion between subtraction and division procedures were not only identified but were able to be recognised as sincere attempts by students to achieve consistency with their earlier learning. Replay of selected sections of the lesson during the interviews and eliciting students' reactions in considerable depth, were invaluable tools which facilitated exposure of students' thought processes.

FOCUS ON A TEACHER

The central concern of the third study was to focus on teachers' work. That is, to find a way effectively to capture and describe the complexity of the planning, choices and actions that make up a typical teaching day, and to do so without oversimplifying, and without allowing an observer alone to decide the meaning of classroom events.

It was therefore essential that the teacher be given every opportunity to explain and comment on the planning and execution of the observed lessons. Since this clearly could not be done during class without unacceptable disruption to normal procedures, videos were chosen as a major means of data collection. It was felt that

videotape offered the particular advantages of allowing events to be replayed "close to their original form" (Jacob, 1987, p.20) and then discussed.

The following data became available for examination:

- transcripts of the videotapes
- transcripts of the audiotaped discussions made before the lessons took place
- transcripts of the audiotaped discussions made while watching the videotapes
- teacher's planning notes
- observer's field notes

Through these data the unravelling of the layers of reality through the perceptions of both observers and participants could begin. The method of analysis is not discussed here. However, a number of comments follow regarding the technique.

The transcription of the six hours of videotape took an enormous amount of time. While Kieren and Munro (1985) argued that "use of the video increased the level of comprehensiveness as well as accuracy, even without a transcript" (p.16), transcription was considered necessary in this study. Avoidance might have led to selectivity and to limitations on what was described. Since conveying the complexity of classroom life was a stated objective, it would have been unjust to oversimplify the research procedure.

But it would have been naive to think that in transferring the video to paper, no interpretation might intervene. On the contrary. The meanings of many sentences cannot be conveyed without the addition of adjectives to describe tone. For instance, the apparently clear 'What do you think, John?' may be a test of John's comprehension, it may be admonitory, or it may be a way of determining the success of a lesson by using an average student as a barometer. The transcriber chooses a word to describe the tone and in so doing has interpreted the event. At least with videotape the interpretation can be reviewed and in this particular study the teacher had the opportunity to offer her own explanations.

Even this posed its own challenges. It was necessary for the teacher to find the time soon after the recorded lesson had taken place to watch the tape and comment on it. At least as much time as the recording was needed to allow for discussion. Apart from the fact that teachers are fully occupied during the school day, their time is often required after school hours. Scheduling an extra task was not easy.

There were, however, clear benefits for the teacher and the researcher in having a tape. Accepting a colleague into the classroom is not an everyday event in schools and therefore was a brave and generous action in a potentially threatening situation. A certain security existed for the teacher in being able to review and explain her work while watching it happen. For both the researcher and the teacher there was also the benefit of having the opportunity to reflect on and discuss issues with a fellow professional.

CONCLUSION

Researchers should not be seduced by the latest advances in technology which might appear to present simple solutions to difficult research situations. As discussed in this paper, videotape as a medium has distinct advantages over other data gathering techniques. But costs are also incurred. Adopting videotape as a research method should be a measured decision linked to the goals of the project and to funding constraints. At the same time, it must be recognised that while videotape may seem an easy way to replace the field observer or to immortalise 'reality', its limitations ensure that this is not the case.

In summary, videotape can benefit research in the following ways:

- Recordings can be replayed, slowed down, skipped over and reviewed. These strengths enable more accurate entries when observational schedules are followed, provide the means for participants to comment and explain behaviours, and allow the researcher to hear and see more than participant observation of the events would allow.
- Material available for transcription and analysis is more detailed than can be gathered from audiotape or field notes. Detailed and focussed verbal exchanges can be determined, accompanied by gestures, movements and

facial expressions. General interactions, the setting and the atmosphere are more vividly captured by the video camera than by other means.

However, just as the computer is unlikely ever to eradicate pen and paper completely, video cameras neither serve all ends nor are without weaknesses. The machine should not be thought the answer to the problem of bias. The camera has its own blind spots. It is but 'one eye', and it can miss sections of the room and some voices.

One of the main advantages of videotape is also one of its difficulties. A large quantity of data is collected. Transcription is often required before analysis can begin. Those without access to considerable research funds should take heed. Delegating the task of transcription is also undertaken at some risk. Descriptions of tone, actions and even dialogue are subject to interpretation.

There are also ethical considerations of confidentiality, and difficulties may be associated with permissions and participant consent. Finally, videotape is open to inappropriate and ethically questionable research practice. For example, permission may have been given for a particular research project to be undertaken. Some time later, the researcher (perhaps short of research funds), wants to investigate a different research question. The temptation to revisit earlier recorded tapes is there. The status of time limitations on the re-examination of 'old' videotaped material is often unclear.

There is little doubt that videotape adds possibilities to research not previously available. We have argued, however, that the medium is not without limitations and that even its advantages have associated difficulties. It is, nonetheless, a valuable and powerful tool in many research settings.

REFERENCES

- Adams, R. S. (1971). A sociological approach to classroom research. In I. Westbury & A. A. Bellack (Eds.) Research into classroom processes (pp.101-117). New York: Teachers College Press.
- Eiser, J. R. (1987). The expression of attitude. New York: Springer-Verlag
- Hamilton, D., & Delamont, S. (1974). Classroom research: A cautionary tale, Research in Education, 11, 1-15.
- Hammersley, M., & Atkinson, P. (1983). Ethnography principles in practice. London: Routledge.
- Hart, L. E. (1992). Two generations of feminist thinking. Journal for Research in Mathematics Education, 23(1), 79-83.
- Jacob, E. (1988). Clarifying qualitative research: A focus on traditions. Educational Researcher, 17(1), 16-19, 22-24.
- Kieren, D. K., & Munro, B. (1985). The observational recording dilemma. Ottawa (Ontario), Canada: Social Sciences and Humanities Research Council of Canada. (ERIC Document Reproduction Service No. ED 297 021).
- Kiesler, C. A., Collins, B. E., & Miller, N. (1969). Attitude change: A critical analysis of theoretical approaches. John Wiley & Sons, Inc..
- Lapierre, R. T. (1967). Attitudes versus action. In M. Fishbein (Ed.). Readings in attitude theory and measurement, New York: John Wiley & Sons Inc. (pp.26-31). Reprinted from Social Forces, 13, 230-237, 1934.
- Leder, G. C. (1990a). Talking about mathematics. The Australian Researcher, 17(2), 17-27.
- Leder, G. C. (1990b). Does teaching equal learning? Keynote address to the 13th Biennial Conference of the Australian Association of Mathematics Teachers. Hobart, Tasmania.
- Leder, G. C., & Forgasz, H. J. (December, 1992). Inside the mathematics classroom. Paper presented at AARE/NZARE Joint Conference, Deakin University, Geelong.
- Mehan, H. (1979). Learning lessons: Social organization in the classroom. Cambridge, Massachusetts: Harvard University Press.
- Peterson, P. L., Wilkinson, L. C., Spinelli, F., & Swing, S. R. (1984). Merging the process-product and the sociolinguistic paradigms: Research on small-group processes. In P. L. Peterson, L. C. Wilkinson, & M. Hallinan (Eds.), The social context of instruction: Group organization and group processes (pp.125-152). Orlando: Academic Press, Inc.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition and sense making in mathematics. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp.334-370). New York: Macmillan Publishing Company.