

Videopapers: Investigating new multimedia genres to foster the interweaving of research and teaching

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This paper reports an ongoing investigation on how mathematics teachers discuss and relate to a new genre of research publication that we call "videopapers." Videopapers are multimedia documents that link and synchronize digitized films with subtitles, text with interpretations and transcriptions, and images or software tools associated to the content of the videopaper. We interviewed pairs of high school mathematics teachers as they encountered and discussed a videopaper based on a PME paper presented two years ago. We reflect on the different roles of the classroom video and the paper and on the process of data analysis enabled by the videopaper.

The Study

The capacity of educational research to influence teaching and learning is often questioned and dismissed (Kaestle, 1993; Sullivan et al., 2000). Educational research tends to be seen unfavorably in comparison to research in the hard sciences. In contrast to fields like medicine or engineering, the evidence generated by educational research seems to many to be inconsequential and inconclusive. This comparison is itself a product of cultural assumptions and expectations. It reflects the notion that valid research should generate evidence out of comparing different teaching and curricular approaches to improve students' learning; accordingly, a research report would have to compare alternatives and show that one is most beneficial. Teachers would then be able to make informed decisions about their practices. This is a view endorsed and pursued by many educational researchers (Campbell & Stanley, 1963; Clifford, 1973). Others approach the role of educational research differently by stressing the need to examine and question different ways of thinking about the nature of teaching and learning. From the latter point of view, a research report is expected to articulate new perspectives on teaching and learning. By questioning assumptions and articulating new possibilities teachers might conceive of their roles differently, or see what students do in a new light. It is not so much a matter of controlled comparisons but about being generative and help to re-think what is usually taken for granted. Case studies (Stake, 1995), ethnographies (Bolster, 1983), and narratives (Carter, 1993) are some of the publishing styles preferred in these lines of work.

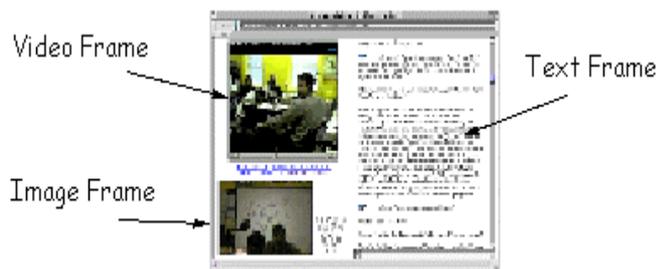
In this paper we report an investigation on how teachers read and talk about case studies based on the analysis of videotaped classroom episodes. The relationship between teachers and research-oriented case studies is the subject of a small literature. Bolster (1983) and Stake (1995) propose that case studies are relevant to teachers because educational events are not governed by formal

rules but by intentions and on-the-spot perceptions, which can only be conveyed by complex and detailed ethnographies. On the other hand, Kennedy (1997, 1999) argues that teachers engage with different pieces of research literature not on the basis of the paper's "genre" (quantitative comparison, case study, narrative, etc.) but to the extent to which they elaborate on issues that matter to them (e.g. classroom management, minority students, etc.). Still others stress the centrality of teachers' participation in authoring these case studies. Cochran-Smith & Lytle (1993) discuss key ideas underlying the "teacher-research" movement, one of whose main tenets is that the relevance of research is associated with teachers' shifting their professional identities, becoming actors in the work of research, and seeing teaching as intimately related to investigating questions on their own practices.

A focus of our study is to understand how the introduction of filmed classroom episodes as part of the case might generate new ways in which teachers perceive and interact with the case. The actual use of video is likely to have a deep impact on how a case is "read" or "viewed." One common observation is that educators who are shown a classroom videotape tend to immediately judge teacher's actions as being more or less good or bad, and frequently contrast his or her actions with how it "should" have been done; it is a tendency to shift the filmed episodes to a background in order to highlight one's own preconceived notions of a correct or ideal course of events. This attitude differs from one in which the observer focuses on the filmed interactions, strives to trace the inner origins of the utterances, and attempts to use the evidence to imagine how things look like to the participants in the film. We will refer to this last attitude by using the term "data analysis."

The emerging technologies of digital video are creating many new possibilities to facilitate data analysis. Digital video is simple to use in a manner that is richly connected to other forms of information (e.g. text, images, subtitles, software simulations, etc.). These possibilities are beginning to be exploited both for the development of research (Hall, 2000; Stigler & Hiebert, 1997), and for teachers' professional development (Lampert & Ball, 1998). Sabelli and Dede (1998) offer as an example research by Jacobs et al. (1997), which involves the "collaborative annotation of video-based case studies of educational practice that include ancillary information such as student products and teacher reflections" (p.9).

Together with other colleagues, we are working to develop a new genre of research publishing that we call "videopapers." Videopapers, as we conceive of them, are multimedia documents that include a text frame, a video frame, and an image frame:



Videopapers can be seen with a web browser, such as Netscape. All the components are linked and synchronized. For example, buttons can be inserted in the text that will play a pre-selected interval on

the video; images can be made to appear at particular times in the image frame; and the video can trigger the display of certain pages on the text frame. In order to produce a videopaper we have developed a software tool called "VideoPaper Builder"ⁱⁱⁱ that allows authors to interconnect and synchronize the different components without having to be a programmer or even technically savvy.

In order to conduct the present study we chose a paper that had been presented at PME in Israel (Solomon & Nemirovsky, 1999), developed a videopaper out of it, and interviewed high school mathematics teachers. We conducted and filmed interviews with pairs of teachers. The teachers were asked to read the paper in advance. Then they were introduced and given access to the videopaper during the interview. The paper is based on a 16-minute classroom conversation in a high school math class taught by Solomon. The two main themes of the paper are the nature of open-ended problems and the sources for the "sense of direction" emerging in a classroom conversation. The authors argue that what makes a mathematics problem open-ended is not so much its textual definition but the classroom culture within which it is discussed and figured out. They also contend that the sense of direction of a mathematical conversation does not follow pre-planned paths and it is co-developed by the teacher and some of the students. The videopaper includes the text of the paper, the 16-minute digitized film with subtitles, and synchronized images displaying the content of the overhead transparencies being projected in front of the class.

Our approach to the analysis of the videotaped interviews shares a number of commonalities with Interaction Analysis as described by Jordan and Henderson (1995), and the interpretive approach described by Packer and Mergendoller (1989). Rather than approaching the filmed interviews with a predetermined coding scheme, we allowed the analysis to "emerge from our deepening understanding" of the events unfolding on the video-taped record (Jordan & Henderson, 1995. p. 43). We treated the participants' utterances and actions as processes accomplished over time and in interaction with others and we focused our attention on the details and meanings of these actions and utterances (Packer & Mergendoller, 1989). Our data analysis took place in a group of four researchers with varying interests and expertise who continually challenged each other's observations and required of each other the grounding of interpretations in observable events on the video record (Jordan & Henderson, 1995. p. 45).

For the purpose of presenting our analysis we will excerpt from two interviews. One interview was with June and Ron, who are beginning teachers, and

another with Cara and Cher who have almost 30 years of teaching experience. All of them teach mathematics in high schools located in the Boston area.

The Interviews

We organize the selected excerpts from interview transcripts in two parts: 1) Reading the paper/watching the video, and 2) Data analysis.

➤ Reading the paper/watching the video

Before the interview, teachers had read the paper, which included a transcription of the classroom conversation integrated with commentaries and analysis. A transcription captures some aspects of a classroom interaction but it necessarily leaves out many others. Transcribing is selecting aspects deemed to be important and making them suitable for the print medium. A large amount of "filtering" happens in transcribing classroom interactions. The reader is expected to reconstruct the events and therefore she has to assume whatever had been filtered out. In order to "picture" what went on, it is essential for the transcript's reader to project his own assumptions. Although not everything falls under the lens of the camera and the microphone picks up only part of what is being said, a video record undergoes less filtering than a written transcription. Film preserves the original tones of voice, gestures, facial expressions, etc. Another difference is that the video introduces its own time: if an utterance took 3 seconds, one has to spend 3 seconds to hear it, whereas the reading of its transcription is not constrained by the original duration. There were many examples of how these differences played out in teachers' conversation. The one that we have chosen took place in the interview with Cara and Cher. As they read the paper, they "pictured" a certain classroom interaction that resembled, in many ways, the kind of interactions they were used to in their own classrooms. Their implicit picture positioned Solomon standing at the front of the classroom next to the overhead projector. Right after viewing the videotape, Cara and Cher commented with surprise on the fact that Solomon was seated and reflected on their own perceptions on "being seated:"

Cara: I still take a negative connotation to being seated during a class. I mean, it's ingrained in me, you have to be out there performing. So that was my first observation of the film, was, gee he was seated. And it was a good thing. I mean, I took it as a supportive, he's part of the, not part of the discussion. He's letting them do it, and he's just writing down their observations.

(...)

Cara: I mean, the whole effect that he was seated.

Cher: That makes a big difference.

Cara: That physically changes the whole climate of the classroom. At least in a math classroom. I don't think it's so much in a history classroom, or an English classroom, where they're reading and writing papers and all. Maybe I'm wrong. But think from your math classrooms, when you came in, didn't you more or less expect the teacher to

be up front, doing something? If you think back? (...) That role is very slowly changing in math classes. (...) because I think it speaks volumes. Rather than being Moses on the mountain, handing down the things.

The transition from reading the paper to watching the video prompted Cara and Cher to encounter their own tacit assumptions. In addition, they felt that reading the paper prior to watching the video was important in another regard: getting a sense of what to look at in the video and approaching the video with *their own* questions in mind. For example Cara felt puzzled by how open-endedness had been characterized in the paper. She commented on this as she was watching the video for the first time:

Mr. Solomon {in video}: There's not necessarily one correct answer.

Cara: See, that part I didn't understand.

Later she clarified her comment:

Cara: the one thing that disturbed me when I read this {paper}, and was anxious to see it in the video, is this, the concept of an open-ended question. And this is something we were kicking around a lot.

This role of "paper-reading" as a source of questions and issues with which to watch the video was made explicit at a later part of the interview:

Teresa: Was it beneficial for you to read the paper physically before you came in and watched the video?

Cara: Yes. {Cher: Definitely.} Yeah. Because I knew where it was going to head to. You know what I mean? I would have been pausing it and thinking things out myself, you know. Trying to keep at the same level as the student. And if I hadn't been prepared, I wouldn't have known what to be watching.

Cher: Well, yeah, and you could watch this, since you, since I knew what the, where it was going. Watch this, and focus on the watching instead of looking at what was going on and watching at the same time. So I think it was good to have, I mean for myself.

➤ Data analysis

June came to the interview with a deep interest in figuring out why Solomon's class had solved a problem of number sequences using successive differences. This solution was for her an unusual one, and she wondered whether it would have ever taken place in her own class. This concern of hers led her and Ron to work on data analysis in order to trace the origins of this idea within the filmed classroom conversation. Their data analysis was grounded in their non-linear examination of the video, with important references back to the paper, and took a form that we call "narrative account." Their narrative account for the origins of the "differences of the differences" idea integrated rich perceptions of the film, which gave them a sense of what kind of persons the students were and of their subjective experiences:

June: {referring to one of the students, Jamal} He wants to see the numbers up there. Maybe he's a visual guy. Maybe he's used to saying I'm seeing something here and my gut tells me that there's something about this, and throw it out, and let's see if somebody else in the class picks up with a fresh brain. The fact that he says put the numbers up there, I think, (...) he has a gut feeling about that.

June and Ron's development of a narrative account prompted them to search for evidence regarding "who had said what" and "when" by going back and forth in the video and in the paper. Their emerging narrative became expressed in a typical linguistic form: "so and so said this and then someone else....":

June: And then Nadia just keeps plugging away, and then she realizes that she did something wrong with her subtraction, and she says ok, wait I might have a different number. I forget where {in the paper} that is. {Flipping through the hard copy of the paper.} And she's like working away there, while other people are discussing stuff. Ok. yeah. {Finds reference} Nadia says. "I didn't stop at finding differences." She's the one who went to the differences between the differences. I think. And, then she got 12, and then 16 ... and then Jesse says "maybe it's 18." And then Nadia says ok wait, and she goes back. And she's plugging away at the numbers while everyone else is talking, and then she comes back. And then she says 125. So, she obviously made the correction and went back out, and did the reverse of taking the differences by adding on 6 to get the next one, and then 24 to get the next one and then 125. Cause that's not recorded in the conversation, nor in the video.

Both the sequence of the paper's pages as well as the video's timeline were important tools to organize ideas and to get the sense of "before and after" relating the different events that took place during the classroom conversation. Note that while their narrative account incorporates many elements visible in the film, it also reflects others that are not recorded but that were likely to have happened, such as when June said "obviously" and stated an inference about Nadia's approach that was recorded neither in the video nor in the transcript. The following excerpt shows Ron's development of a narrative account and June's repeated contributions and occasional surprises.

Ron: Maria said she did the differences.

Teresa: where are you {to Ron who was controlling the movie player on the computer screen}?

Ron: She says when she went home, she did the differences. She did multiplication. Alright. So that's where the word differences comes up first.

June: ohhh {surprised}

Ron: Then Margaret says there's no sequence, the only common ... but then for some reason, where does the differences {of differences} come out?

June: Jamal again.

Ron: like who says 1, 8, 27, 64 ... I mean, 7 ...

June: Jamal, here {points to quote in transcript}. He says ...

Ron: the differences between the differences between ...

June: {Flipping through paper} He comes up with 7 and Molly quickly says the other two numbers.

Ron: It says {pointing to quote in text} "she probably had already taken the first differences."

June: Oh right, she reacted, that's right.

Ron: But Jamal was the first that brought the differences in the discussion.

June: and I think that he sensed that there were other people that, since Molly saw it, he said yeah, yeah, he wanted {gestures forwards to imaginary board} to see them {the numbers} up there. And I think that kids sometimes do do that. They'll say, I know there's something in there.

Note in the last remark by June her analysis of Jamal's actions that had introduced the differences of the differences approach, albeit in an unintended way. According to June, Jamal wanted to have his number sequence written on the overhead transparency because he felt that "there is something there" although he was uncertain about what that "something" was; and she immediately connected this observation about Jamal with a personal statement: "kids sometimes do do that." This excerpt shows how a narrative account expresses at once: grounded evidence (e.g. "here, he says"), interpretations ("he sensed that there were other people..."), and the background of life experience ("kids sometimes do do that.").

Conclusions

Paper and video are both important in different ways. The classroom videotape makes possible to get a "feel" for what teachers and students say or experience, to encounter one's own assumptions about the classroom interactions, and to formulate questions with a great degree of ownership. The paper introduces a particular interpretation, it helps to develop a sense for "what to be watching", and its transcriptions highlight what, among the massive amount of information available in the video, appears significant to the author.

Digital video embedded in videopapers facilitates data analysis by enabling a non-linear search of utterances and events and the development of complex narrative accounts encompassing grounded evidence, interpretations, and the teachers' background of life experience. This suggests that videopapers may be particularly suitable for teachers' engagement with data analysis.

References

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Bolster, A. S. J. (1983). Toward a more effective model of research on teaching. *Harvard Educational Review*, 53, 294-308.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and Quasi-Experimental Designs in Research on Teaching*. New York, NY: Macmillan.

Carter, K. (1993). The place of history in the study of teaching and teacher education. *Educational Researcher*, 22(1), 5-12.

- Clifford, G. (1973). A history of the impact of research on teaching. In R. M. W. Travers (Ed.), *Second Handbook of Research on Teaching* (pp. 1-46). Chicago, IL: Rand McNally.
- Cochran-Smith, M., & Lytle, S. L. (Eds.). (1993). *Inside/outside : teacher research and knowledge*. New York: Teachers College Press.
- Hall, R. (2000). Video Recording as Theory. In A. A. Kelly & R. A. Lesh (Eds.), *Handbook of Research Design in Math and Science Education*. Mahwah, NJ: Lawrence Erlbaum.
- Jacobs, J. K., Yoshida, M., Stigler, J. W., & C. F. (1997). Japanese and American teachers' evaluations of mathematical lessons: a new technique for exploring beliefs. *Journal of Mathematical Behavior*, 16(1), 7-24.
- Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *Journal of the Learning Sciences*, 4(1), 39-103.
- Kaestle, E. (1993). The awful reputation of educational research. *The educational researcher*, 22(1), 23 and 26-31.
- Kennedy, M. (1997). How teachers connect research and practice. *Mid-Western Educational Research*, 10(1).
- Kennedy, M. (1999). A test of some common contentions about educational research. *American Educational Research Journal*, 36(3), 511-541.
- Lampert, M., & Ball, D. L. (1998). *Teaching, Multimedia, and Mathematics: Investigations of real practice*. New York: Teachers College Press.
- Packer, M. J., & Mergendoller, J. R. (1989). The development of practical social understanding in elementary school-age children. In L. T. Winegar (Ed.), *Social interaction and the development of children's understanding*. Norwood, NJ: Ablex.
- Sabelli, N., & Dede, C. (1998). Integrating educational research and practice: Reconceptualizing the goals and processes of research to improve educational practice.
- Solomon, J., & Nemirovsky, R. (1999). *This is crazy. Differences of differences!" On the flow of ideas in a mathematical conversation*. Paper presented at the 23rd annual meeting of the International Group for the Psychology of Mathematics Education, Haifa, Israel.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.
- Stigler, J. W., & Hiebert, J. (1997). Understanding and Improving Classroom Mathematics Instruction, An Overview of the TIMSS Video Study. *Phi Delta Kappan*, September, 1997.
- Sullivan, P., Boero, P., Brown, M., & Fou-Lai, L. (2000). *Teaching and learning in school mathematics: What has research told us about mathematics teaching and learning?* Paper presented at the 24th Annual meeting of the International Group for the Psychology of Mathematics, Hiroshima, Japan.

ⁱ The VideoPaper Builder for Macintosh can be downloaded from www.terc.edu/brp/vpb/vpb.html