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ABSTRACT

The Secondary Analysis of TIMSS (Third International Mathematics and Science Study) Video Data study used TIMSS Videotape Classroom Study data and vPrism software to achieve methodological and substantive findings on teacher quality, instructional practices, and classroom interactions. It discussed methodological and technical issues arising during secondary analysis of existing data sets using specific software applications. The paper examines three methodological findings from using the video data and software to explore teachable moments: the technical dictates of how an utterance is defined and operationalized for coding may impact a study's unit of analysis and overall design; coders coding in pairs or groups may be more reliable; and it is important to do the empirical work of developing a study design, codes, and coding and analysis protocols and to critically reflect on assumptions and processes involved. This secondary analysis resulted in increased awareness of the significant interplay between the unit of analysis, the coding unit, and the software application. The study showed that it was fruitful to use the TIMSS video data set for secondary analysis. There appeared to be an instructional practice called a "teachable moment" as defined, and it was possible to develop, apply, and test codes and their reliability. (SM)

LEARNING FROM TEACHABLE MOMENTS: METHODOLOGICAL LESSONS FROM THE SECONDARY ANALYSIS OF THE TIMSS VIDEO STUDY

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Learning from Teachable Moments: Methodological Lessons from the Secondary Analysis of the TIMSS Video Study[1]

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by

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Introduction and Background

Since 1994, substantial interest has been directed toward large-scale, quantitative studies that use video as a data source. One such study, the Third International Mathematics and Science Study (TIMSS) Videotape Classroom Study (Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999), videotaped over 225 8th grade mathematics lessons in Germany, Japan, and the United States. The Third International Mathematics and Science Study – Repeat Videotape Classroom Study (TIMSS-R) (TIMSS-R, forthcoming) has gathered video data of over 1100 mathematics and science lessons in Australia, the Czech Republic, Hong Kong, Japan, the Netherlands, Switzerland, and the United States. Based on nationally-representative samples of 8th grade classrooms, these video data sets offer unique information about teaching and learning within and across nations. They also draw upon new video format and analysis technologies which make it easier to gather, store, and manipulate large quantities of video data. The result has been valid and reliable statistical analyses of classroom interactions and practices, within cross-cultural, comparative contexts. Also, the TIMSS Videotape Classroom studies have provided, and will continue to provide, opportunities for secondary analyses.

Using video as a data source, along with specific software applications for manipulating it, will likely become more common in coming years for large-scale survey-type research and smaller scale ethnographic or case studies alike. For this reason, it seems important to learn more about the substantive benefits of these new types of research approaches and their methodological and technical intricacies.

The study we report on here – the Secondary Analysis of TIMSS Video Data Study (SATV) -- was undertaken by the Educational Statistics Services Institute (ESSI) of the American Institutes for Research (AIR) for the National Center for Education Statistics (NCES). The SATV study's broad charge was to use the TIMSS Videotape Classroom Study data set and the vPrism software application (developed for use by the original TIMSS Videotape Classroom Study) to achieve both methodological and substantive

[1] Because of the study's size and preliminary nature, it would be inappropriate to generalize results to other video studies using similar methods – especially ones at a larger scale. While results do point to areas of interest, any questions that the SATV study raises warrant additional exploration and research in order to further develop the current knowledge base regarding the use of digital video in research.

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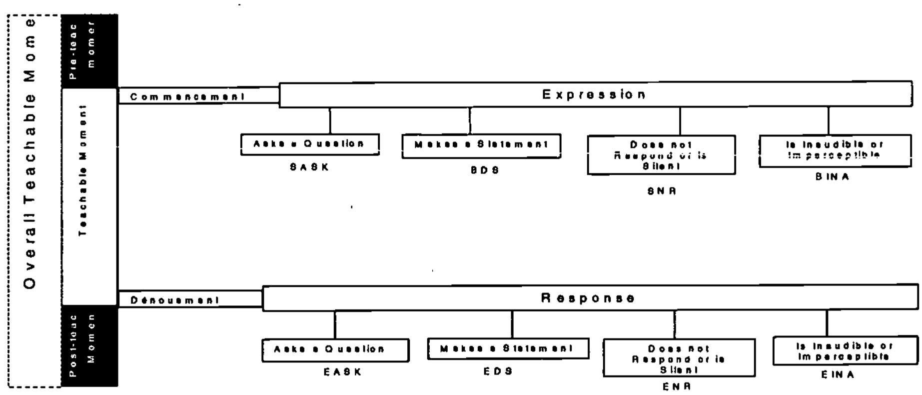
findings. The study sought to shed light on substantive issues related to teacher quality, instructional practices, and classroom interactions. In the process, however, it also explored methodological and technical issues that might arise when doing secondary analysis of an existing data set using a particular software application. In this paper, we report on three methodological findings that resulted from using the TIMSS video data set and vPrism[3] software application to explore "teachable moments."

The first finding concerns the functional interplay between our study's unit of analysis (the utterance) and unit of coding (transcript unit) based on the technical requirements of the vPrism software. The second finding relates to coding procedures and how coding reliability might be increased by asking coders to code as pairs or teams rather than individually. We discuss these findings in more detail below. However, the broad finding of the SATV study is the importance of doing the empirical work of developing a study design, codes, and coding and analysis protocols and, more importantly, of critically reflecting on the assumptions and processes involved. The attention to detail and opportunity for self-reflexive analysis that secondary analyses of video data and data sets can offer are important not only for the new substantive analyses they can provide, but also for the conceptual, methodological, and technical insights that can result from them.

Methods

Teachable Moments

Figure 1. Representation of Teachable Moment and Codes



The SATV Study set out to identify and broadly characterize components of "teachable moments" using quantitative methods and the TIMSS video data. The code development team defined teachable moments as the set of behaviors within a lesson that indicated students are ripe for, or receptive to, learning because they express confusion,

[3] vPrism is a trademarked, multimedia database that was developed to manage and analyze the 250-plus hours of video gathered for the initial TIMSS Videotape Classroom study. vPrism is one of many software applications that links digital video with transcript and other text or object information. Currently sold and supported by Lesson Lab, Inc., contact information for the software and can be found through their website www.lessonlab.com.

misunderstanding, uncertainty, struggle, or difficulty with a mathematical problem, concept, or procedure.[4] It was hypothesized that teachable moments as defined consist of at least three stages – a stage of commencement, a stage of elaboration, and a stage of denouement – and can be behaviorally identified via "utterances." These three stages are graphically represented by the vertical bar at the very left side of Figure 1 above.

The SATV study team drew on the TIMSS study team's definition of an utterance as "...a sentence or phrase that serves a single goal or function" that helps explore how teachers and students used language to "...explain, justify, conjecture, and elaborate on mathematical understandings" (Stigler, et al., 1999, p. 32). Teachable moments were conceptualized as beginning when a student's, students', or teacher's utterance indicated that a student or set of students were having difficulty with a mathematics problem, concept, or procedure. Teachable moments were conceptualized as ending when the student(s) and teacher worked through the difficulty and "moved on." In this phase of the SATV, the study team focused on coding and testing reliability for codes of the beginning utterances of teachable moments. As such, teachable moments are similar to what the TIMSS study called elicitation-response sequences (ER sequences) [5], although the SATV study conceptualized its components differently and, as a result, developed a wholly different series of codes.

The Codes

The SATV study team chose to develop specific codes to identify and characterize only the beginning and endings of teachable moment ER sequences. Codes were mutually exclusive and exhaustive (ME&E - i.e., only one code to describe each event) and consisted of two types: language codes and communication codes. Language and communication codes differed, on-the-whole, for the beginnings and endings of teachable moments. Codes were applied as a time stamp that marked where the beginning or ending utterance occurred within the video and transcript (these were linked by the vPrism software using SMPTE time code markers) and indicate the code type. Because we are not reporting on the substantive aspects of the study in this paper, we do not describe these codes in depth. They can, however, be seen in the boxes along the horizontal lines representing a teachable moment's commencement and denouement in Figure 1 above.

[4] In the NCES SATV Study report/working paper, *Secondary Analysis of the TIMSS Video Data Set: Methodological Findings*, we provide a literature review of scholarship on "teachable moments" and its links to related concepts such as help-seeking, critical moments, critical incidents (Arafeh, Smerdon, & Snow, in review). In further work we would like to explore teachable moments as related to the constructivist notion "zone of proximal development."

[5] The TIMSS Mathematics Content Group defined an ER sequence as: "...a sequence of turns exchanged between the teacher and student(s) that begins with an initial elicitation and usually ends with a final uptake. The ER sequence is a cohesive unit of conversational exchange. ER sequences my consist of a single elicitation, response, and uptake, or they may consist of several of these three utterance types. They may also consist of a single Elicitation without a Response or Uptake, or of single Elicitation and Response without an Uptake. A New ER sequence begins when there is a new Elicitation. A new Elicitation is one that requests new information. Repetitions, redirections of the initial elicitation to other students, or clarifications are not considered new elicitations (Stigler, et al., 1999, p. 113-114).

The language and communication codes, together, formed what we termed "content codes" describing the type of language used to initiate or end a teachable moment (e.g., a question, a statement, a silence, etc.) and the type of communication intended (e.g., a request for clarification, an answer given, etc.). Every teachable moment beginning and ending were given both a language code marker and a communication code marker which would both share the same teachable moment beginning (intime) or ending (outtime) timestamp. Thus, the content codes also served another coding function: to mark the temporal intime or outtime of a teachable moment's constitutive beginning and ending utterances.

Coding Procedures and Reliability Testing

Codes were technically applied using the vPrism software application. Both the code development team (master coders) and the independent coders (coders) of the study initially marked codes by playing the video, identifying the beginning of the beginning utterance of a teachable moment, the end of the ending utterance of a teachable moment, and then marking the two language and communication codes to be associated with that time stamp. Initially, this was done "on-the-fly" (i.e., as the video was running) so as to mark, exactly, the word beginning or ending an utterance (see Figures 2 and 3, below). However, on-the-fly coding proved to be difficult and was feared to affect the reliability of the codes and coding merely because of the technical difficulty of inserting an accurate mark on-the-fly. As a result, the code development team/master coders decided to apply codes based on those already embedded in the transcript – what we have termed "transcript units" (also see Figures 2 and 3, below). Thus, codes were applied by highlighting the transcript unit in which a teachable moment's beginning or ending utterance occurred, and using the time stamp marked for that unit as the intime or outtime codes.

Figure 2. The vPrism Interface Showing A Transcript Unit (shaded with arrow)

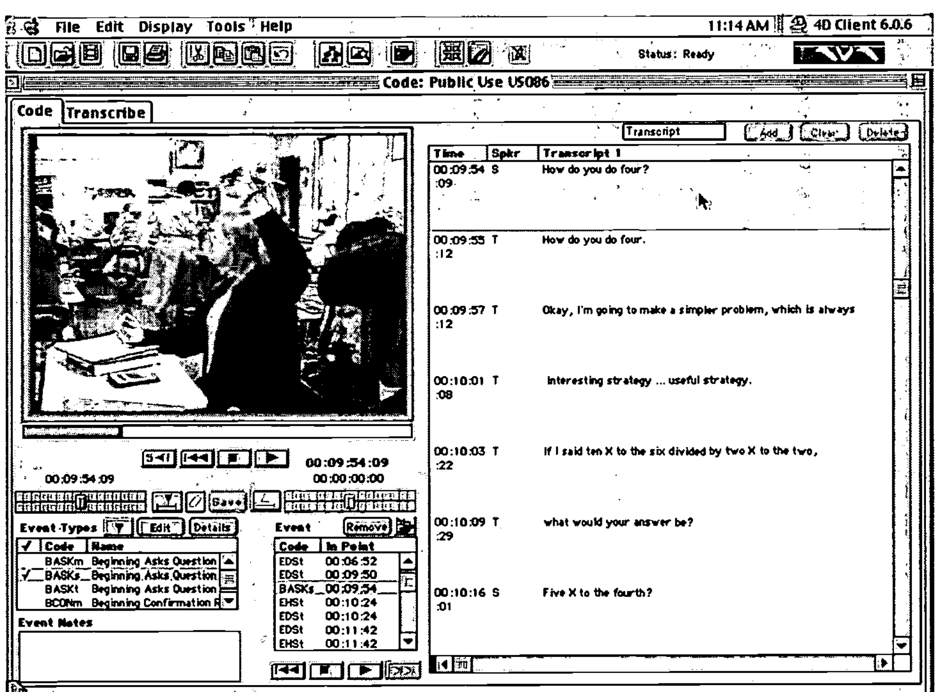


Figure 2 shows the vPrism graphical interface. The video plays in the top left window, the transcript (linked to the video) scrolls in the large window on the right, and the three smaller windows on the bottom left are for coding/timestamping the video or marking the video with notes. An example of a transcript unit containing an utterance that begins a teachable moment is shaded with an arrow pointing to it.

Figure 3 below graphically demonstrates the difference between the two types of coding units that were used in the SATV study using the utterance from the transcript in Figure 2. The study began by coding utterances using marks for the beginning of its beginning -- "how" -- using an on-the-fly coding approach. The result was a one-point timestamp that marked the utterance only on one point – the word that the coder marked (Figure 3, 1). When coding the second type of unit, the transcript unit, the timestamp would not mark the word that began or ended an utterance, but the entire utterance (Figure 3, 2). The SMPTE timestamp at the left of the shaded transcript unit in Figure 2 is the same timestamp that the language and content codes would share.

Figure 3. Differences Between Units of Coding

1) Utterance In-Point Timestamp:

Student: *<u>How</u> do you do four?*

....-3 –2 –1 TM +1 +2 +3 +4 +5 +6 +7 +8 +9 +10 +11 +12

2) Transcript Unit In-Point Timestamp:

Student: *<u>How do you do four?</u>*

TM

Two types of inter-rater reliability of coders were tested: 1) temporal reliability and 2) content reliability. A temporal code match occurred when coders marked the in- and out-times of their codes within plus (+) or minus (-) one second of the in- or out-time marks made by the master coders – a three-second window of time in which codes could occur and count as an agreement. A content code match occurred when coders agreed with the master coders on the type of language and communications codes applied to an in- or out-point when temporal agreement was met. An 80% agreement reliability threshold was sought.

Figure 4. Intime Reliability Percent Agreement By Videotape Coded

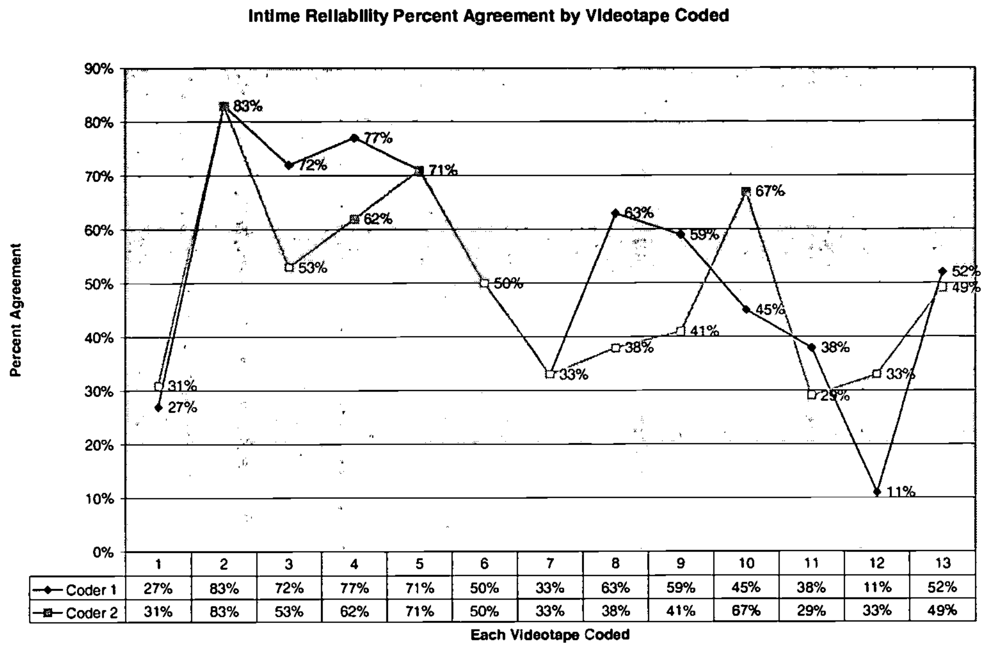
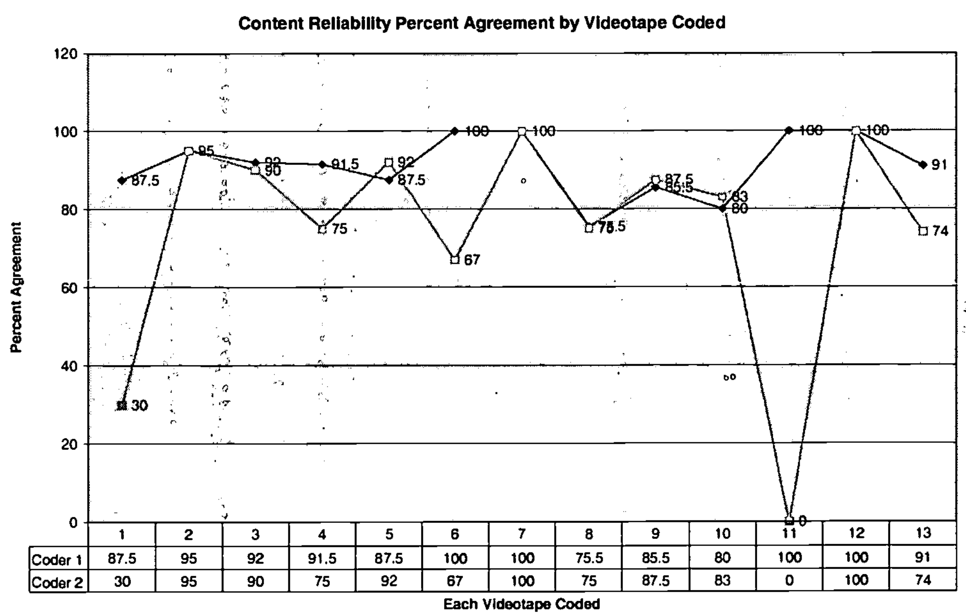


Figure 5. Content Reliability Percent Agreement by Videotape Coded



As demonstrated by Figure 4 above, coders had difficulty achieving 80% reliability on the temporal intime codes. However, Figure 5 shows that content code agreement was highly reliable when coders found and marked the temporal intime codes correctly. This would suggest that either the coding unit of analysis (i.e. the beginning of the beginning of the utterance), the codes, or coder training or performance needed modification. Coders did reach reliability on temporal codes in one case: the one time that they coded together as a pair (Figure 4, videotape 2). This finding will be discussed in more detail below.

To investigate why reliability of intime codes was difficult for coders to achieve, the SATV team pursued two different courses. One course, described above, was to better ensure that coders and master coders were coding the same utterance by not coding "on-the-fly" but, instead, to code by transcript unit – a technically more stable mark. The second course of action was to do an analysis that would determine whether or not temporal code reliability was negatively affected because coders were coding incorrectly or were coding entirely different utterances.

The analyses the SATV team pursued to explore whether coders were coding incorrectly, or were coding different utterances, was initially based on the assumption that coders were coding the beginning of the beginning of a utterances. However, as noted, coders had switched to coding utterances by transcript unit so this basis was incorrect. This finding that modification to the coding unit from timestamping the beginning of the beginning to timestamping the transcript unit required modifications to the basic study design only became clear through the empirical work of exploring why temporal reliability was low overall. In other words, if the SATV study had taken the results at face value (i.e. that the codes or coders were unreliable), and had not embarked on an empirically-based methodological analysis of why this was the case, the interplay between study design, coding unit, and technical software reported here would have gone undetected.

The first step of this analysis involved determining whether opening the code intime agreement window from +/- 1 second to, say, +/- 12 seconds would result in higher intime reliability and, if so, how content reliability would be affected. As part of this analysis we calculated the average utterance length for the particular teachable moments we were testing so that we could have an educated estimate of when a new utterance would likely begin for the particular teachable moment under consideration. As a result of designing and interpreting these analyses, however, it became clear that when we modified our coding procedures for increased accuracy by adopting the transcript unit timestamp method of identifying teachable moment beginnings and ends in place of the on-the-fly timestamp method, we had actually created a king of "proxy" for utterance intimes that did not mark the beginning of the beginning of an utterance but rather an utterance in its entirety -- a unit of the transcript (Figure 2). Thus, the first finding that our analysis produced was that we were conceptually conflating our unit of analysis and our operationalization of it using the coding unit.

Upon further reflection, the SATV study team determined that the transcript unit could and did serve as a viable proxy for utterance that would work for our analysis. This was because we weren't necessarily interested in the <u>time</u> of the of the utterance beginning per se but, rather, in the word(s) and meanings with which it commenced. Our reliance on the time stamp mark – whether the exact inpoint of the beginning of the beginning of the utterance or the timestamp of the proxy transcript unit – had been driven by the dictates of the software and our desire to create a system of inter-rater reliability testing that was highly accurate. It is only as the result of this analysis exploring why coders were not achieving necessary levels of temporal reliability did we realize that our conceptualization of a construct like "utterance beginning" and our operationalization of it as, first, a unit of analysis and, next, our development and operationalization of a coding unit required knowledge of the technical "workings" of the vPrism software in order to ensure that our study design and approaches resulted in coding and measuring what it is that we actually intended.

A different but also important finding was that coder reliability seemed to be positively affected when coders coded as a pair. In fact, the only time that SATV coders reached 80% reliability was when they coded together as a pair – a practice the SATV team adopted in one instance as a training intervention. There is little to report about how and/or why this transpired because the SATV team did not explore the phenomenon further. When reliability was tested and found to be amiss after the coders' initial course of training, the SATV study team asked coders to train together so that they could discuss codes between themselves and reason with one another about where and how they should be applied. SATV coders were only asked to code together once, so this finding that code and coder reliability may be increased by training and coding in pairs needs further investigation.

Implications

These two findings – 1) that the technical dictates of how an utterance is defined and operationalized for coding may have implications on a study's unit of analysis and overall design and 2) that coders coding in pairs or groups may be more reliable -- do bring to light some important issues related to doing secondary analyses of video data. One issue involves the way in which empirical analyses drive and/or modify theory and method with important implications for study design and execution.

The SATV team modeled its methodological approach to teachable moments largely on the work of Bakeman and Gottman (2000) and the TIMSS Videotape Classroom Study (1999). The study designs, units of analyses, coding units, and coding and analysis procedures for those studies were appropriate for their particular research topics and questions. While aspects of their approaches were useful for the SATV study, as a secondary analysis looking at different kinds of substantive issues, it was necessary to make modifications. Doing so, however, resulted in new, often unanticipated, challenges that needed to be perceived and addressed.

One result of the SATV team's secondary analysis experience is that we are more aware that there is a significant interplay between the unit of analysis, the coding unit, and the software application. Thus, it is necessary to conceptualize and operationalize each of these so that the coding units and the analyses they are subjected to are driven more by conceptual intentions and less by a software's technical functionalities. This is not to say that software applications are limited and do not allow researchers to do the kinds of analyses that they need or want to do. In fact, without many of the software applications currently available to us many of the intricate alphanumeric and image-based analyses that we pursue would be impossible. Rather, it is to say that it is important for researchers and the supporters of research to understand that now that these technical "handmaidens" are available and being used ever-more-widely, their capabilities do affect the research process quite elementally. Thus, research that helps understand how technical and methodological components of a study affect its conceptual and procedural elements is highly important.

We are also suggesting that exploring the use of pairs of coders is something that may be quite worthwhile. The SATV study team's finding that coders coded more reliably as a pair is supported by Frederiksen et al. (1998) who found that individual video analysts (scorers) often noticed similar features of a particular teacher's teaching, but failed to reach agreement on ratings and the organization of their observations (G=.22). When scorers worked in pairs, however, they were able to reach agreement with each other as well as reach agreement more often with other scoring pairs (G=.37).[6] It also was the case that the more scorers used, the more reliable estimates became (.28 for one scorer versus .62 for four scorers, on average). Since our limited SATV experience was similar, we suggest that further exploration of whether pair or group coding results in greater reliability be tested further. We feel this is especially important for coding tapes from multiple countries or cultural contexts where teams comprised of different relevant cultural experts can corroborate and hone their codes as they strive to agree on coding intimes or events together.

Overall, the empirical work we did through this secondary analysis of the data lead us to believe that future methodologists of both primary and secondary studies will benefit from thinking through these issues as they conceptualize and carry out their work. However, these findings illustrate a third issue: continued secondary analyses of video data, both substantive and methodological, are necessary to learn more. Secondary analysis of video survey data is an emerging field, as the technologies that make it possible (such as digital video) were not available on a wide scale until recently, and hence, the methodologies are also in the developmental stage. Further work in this area is particularly important in the case of international and/or cross-cultural studies, where linguistic and cultural differences introduce additional barriers to understanding and accurately coding classroom behavior. Such considerations may warrant the development of some guidelines outlining technical and methodological issues to consider and pitfalls to avoid when using a particular video data set or set of technical analysis tools.

Conclusion

The TIMSS Videotape Classroom Study advanced new technologies and methods that have widened possibilities for using video as a data source more generally. For example, when video is collected as a "survey," it becomes possible to validate certain survey data against certain video survey data-based standards. Video data can also be used as to exemplify survey findings making it possible to "see" aspects of the background survey and assessment data "come alive." Through this, differences and similarities in educational systems, curricular coverage, instructional practices, and teacher and student

[6] These scores were calculated using generalizeability analyses, which are equivalent to a reliability coeffiecient.

behavior can be apprehended that survey measures are unable to capture. Video data can also capture multiple cultural nuances, and be subjected to secondary analyses from multiple theoretical and methodological perspectives.

The SATV study analysis showed that it was very fruitful to use the TIMSS video data set for secondary analysis. There does seem to be an instructional practice called a "teachable moment" as defined, and it was possible to develop, apply, and test codes and their reliability. It was only through the process of undertaking empirical study, however, that finer technical, methodological, and conceptual aspects of the SATV study became apparent and required further exploration. In particular, we determined that sometimes it is technically necessary – and methodologically viable – to reconceptualize the interplay between a unit of analysis, its logical unit of coding, and its actual or proxy unit of coding. Likewise, we determined that there may be some very good reasons to undertake coding in ways that are not traditional to observational studies such as coding in pairs.

We suggest that more work should be done to explore more clearly how utterances can be better conceptualized and operationalized as coding units, and whether and how video and transcript data might be prepared to make this unit of analysis more cleanly accessible for coding and analysis purposes. Likewise we suggest that coding in pairs or groups be further explore and, perhaps, subjected to experimental study, to determine whether or not this offers more coding reliability and, therefore, analytic accuracy. We suggest, finally, that this is particularly important to undertake using cross-cultural data and multi-cultural research and coding teams.

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