The contribution of the student voice in classroom research: a case study[1]

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This paper addresses issues related to the triangulation of data in classroom video research—in particular the contribution of the student voice to the research methodology. The case of a Year 8 boy—Leon—is used to illustrate the multiple interpretations that may result when the student voice is included. This case draws attention to the benefits of a research methodology that increases validity by providing additional sources of data and raises issues regarding the weighing of evidence where differences in interpretation arise. This case is used to illustrate the use of triangulation and the evaluation strategies that take advantage of the multidimensional data to synthesise the complementary interpretations derived from the different data sources into a coherent portrayal of an individual's classroom practice.

Introduction

It is our contention that research into social interactions in complex social settings must draw on the widest possible range of data types. Although the survey-style analyses undertaken by Jim Stigler and James Hiebert is a rich source of information on classroom processes, like many research designs it omits 'the student's voice'. The Learner's Perspective Study used three video cameras to ensure that the nature of student classroom practice is captured in at least the same detail as teacher practice. In addition, post-lesson video-stimulated interviews offered students the opportunity to reconstruct their classroom experiences, their motivations, and their practice. This richness of data poses new methodological challenges: In particular, how are we to construct our portrayal of the classroom from the combination of these complementary data sources? In this paper, we illustrate the complementarity and occasionally conflicting interpretive accounts of classroom practice generated from these different data sources. The focus of our discussion is the difference in two interpretations of the classroom behaviour of a Year 8 student, Leon, in one lesson. Each author's interpretation was based on a different data source: a) observation of Leon and his friend Pepe during the lesson; or b) the video stimulated reconstructive interview. In this paper, these interpretations are compared to explore the contribution of the student voice to classroom research. Our intention is to firstly précis those two analyses separately and then to attempt a synthesis, drawing on additional evidence for the purpose of constructing a coherent and plausible account of Leon's actions during that lesson, and even of the motivations that prompted those actions. In particular, the significance of the complementarity of such data is addressed and the positivistic convergence on a single 'correct' interpretation is contrasted with the richness offered by the synthesis of complementary interpretations (see Clarke, 2001).

Literature review

The TIMSS video data (Stigler & Hiebert, 1997) focused upon the teaching of Year 8 Mathematics in The USA, Germany, and Japan. This study did not attend to student behaviour and is composed of single lessons rather than a sequence of lessons taught by the same teacher. Clarke's Classroom Learning Project research design (Clarke, 2001) was developed to provide data appropriate to the study of teaching and learning rather than the study of teaching in isolation from the learner. Clarke's design included two cameras in the classroom—one focused on the teacher and one focused on a pair of students—over a sequence of lessons. The student pair video-taped in a particular lesson participated individually in video-stimulated interviews after the lesson. Clarke (2001) cited Nisbett and Wilson (1977) and Ericsson and Simon (1980) in his justification of the use of student video-stimulated reconstructive interviews as a valid data source and in his recognition of possible limitations to this data source. Nisbett and Wilson state that people can provide accurate reports of their own cognitive activity if salient stimuli are used to assist this reconstruction. Clarke's (2001) use of video-stimulated recall provided salient stimuli to elicit valid reconstructions because it enabled the student to view his classroom activity and see himself listening to, discussing, and writing about his mathematics. These video-stimulated interviews with their specific focus on the lesson addressed Ericsson and Simon's finding that inconsistent retrospective reports could result from too great a reliance on researcher inference when the probes were too general to elicit the information required to answer the research question. Tierney's (2000) descriptions of situations in which testimony is used to reconstruct historical events parallels the situation in which the

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video-stimulated student interview is used in conjunction with video evidence to study learning in mathematics classrooms (Clarke, 2001). In each case, the person is recounting their individual perspective of prior events in which they participated. The inclusion of voices that 'historically have been silenced or excluded' (Tierney, 2000, p. 540) acknowledges the legitimate subjectivity of the individual participants who previously may not have been given adequate emphasis (Clarke, 2001). Alternative interpretations of testimony take into account the 'fluid nature of identity' (Tierney, 2000, p. 539); and in adolescence this fluidity of identity is likely to be more pronounced (Erikson, 1968). Inferences regarding student inattentiveness in class provide a useful example of how interpretations of behaviour based on a single data source can mislead and misrepresent the behaviour being studied. Clarke (2001) discussed how a teacher's characterisation of a student as inattentive appeared to be consistent with the video record. In fact, the student herself, on viewing the videotape, commented that it did not look as though she was paying attention at all (Clarke, 2001, p. 298). During the post-lesson video-stimulated interview, however, the student was able to provide convincing evidence of the extent of her engagement with the lesson content. Such examples make it clear that inferences of student behaviour, and particularly of the affective basis of that behaviour, must be well grounded in the individual's documented statements or actions, and, where possible, corroborated by other data sources such as post-lesson interviews. Clearly, the inclusion of multiple data sources increases the possibility that different interpretations may arise when these different data sources are analysed separately. In such situations the successful synthesis of complementary interpretations (see Clarke, 2001) will depend upon the criteria by which each interpretation is considered to be consistent with all the available data. In this paper we use the case of Leon to: illustrate the complementarity of interpretations drawn from different data sources, and to raise issues regarding synthesis.

Research design, mathematical setting, and research questions

The Year 8 lesson upon which this paper is based was the twelfth lesson in a sequence of fourteen lessons in one set of the Australian data within the broader Learners' Perspective Study designed to explore the teaching and learning of Mathematics as viewed from the perspective of the learner. Two significant characteristics of this study are its documentation of the teaching of *sequences* of lessons rather than one lesson in isolation and the orientation of data collection from the perspective of the student. The methodology includes videotape of the sequence of lessons, post-lesson video-stimulated student and teacher interviews, collection of student work and lesson tasks, and teacher questionnaires (Clarke, 2001). The data from ten to fifteen successive lessons was collected by three video cameras that operated simultaneously in the classroom to display the actions of: (a) the class as a whole; (b) the teacher; and (c) a pair of focus students. Following the lesson, focus students took part in individual audio taped interviews that were stimulated by a mixed image of the video of the teacher (small insert) and video of the focus students (large image). In the Learners' Perspective Study, Clarke has extended his original design (Clarke, 2001) to include: a third camera to capture the behaviours of the class as a whole, and he has given the student the video remote control in the after-class interview. The student was asked to fast-forward the video image to the parts of the lesson that were important to that student to aid student reconstruction of their cognitive processes and their affective responses during the lesson.

Work relevant to Lesson 12 (undertaken in class in the lessons prior to Lesson 12) is detailed in Table 1. By the start of Lesson 12 students had been exposed to the concept of area as the number of squares that fit into a figure and to the formulas for the area of a square and a rectangle. The area of an irregular shape had been explored by counting squares and some students had considered the area of a right-angled triangle.

Introduced prior to Lesson 12	*Activity*
Pre-task A: Area as the number of squares that fit within a space	Rectangles and squares broken into small squares were used to develop formulae for area of square and rectangle.
Pre-task B: Consolidate concept of area	Individual students to trace their own hand and find the area enclosed. Complete for homework.
Pre-task C: [For students who completed the work required in Lesson 11] Think about how to find the area of a right-angled triangle.	Dimensions of a specific right-angled triangle given. A diagram of a right-angled triangle superimposed on the appropriate rectangle displayed (Lesson 11). Teacher did not comment on the relationship between the figures.

Table 1. Mathematical ideas relevant to Lesson 12 introduced by the teacher prior to Lesson 12.

Lesson 12 consisted of three main areas of focus (Table 2). Although the teacher intended to work with Focus 1 and Focus 3, Focus 2 arose in response to a student misconception.

Leon's observed classroom behaviour considered in conjunction with his explanations in his after-class interview raise important questions: (a) In what degree of empirical detail must the researcher ground any inferences made on the basis of video data? (b) By what criteria do we ascertain the reliability of a participant's reconstruction of a social event such as a lesson? (c) What are the implications for classroom research that relies

solely upon researcher inferences of student cognition drawn from a single source (be it classroom video or interview)?

Mathematical Foci in Lesson 12	*Purpose*
Focus 1 Go over homework from Pre-task B (Table 1).	The values found for the areas of several hands were tabulated. A teacher led discussion followed.
Focus 2 Comparison of the characteristics of rectangles and squares.	The teacher question: 'give examples of rectangles with an area of a hundred square centimetres' prompted a student conjecture that 'a square was not a rectangle.
Focus 3 Finding the areas of triangles	Pairs of students were required to find the area of one of three triangles [Triangle 1: acute angled; Triangle 2: right-angled; Triangle 3: obtuse angled].

Table 2. The three main mathematical foci in Lesson 12.

The video record of student practice in the classroom

The three-camera technique employed in the Learner's Perspective Study provides a complete documentation of all Leon's statements and actions throughout the course of the lesson. Although Leon engaged in a significant amount of off-task social interaction (most frequently with girls), he nonetheless engaged in three instances of sustained mathematical activity. Each offers possible insights into the nature of the classroom practices of an intelligent, articulate student whose engagement with the mathematical content of the lesson fluctuated significantly over the 45-minute lesson. With regard to Leon, there appeared to be substantial video evidence of inattentiveness:

- Whispered prompting from Pepe, prompting an answer related to homework (~ 4 min.)
- Whispered prompting from Earl, prompting an answer to a teacher question (~ 12 min.)
- Question to Elina regarding which triangle he and Pepe should be working on (~24 min.)
- Question to Pepe regarding which triangle they were working on (~32 min.)
- Pepe's attempts to get Leon on task, which included slapping his face (~35 min.)
- Question to Pepe, prompting a frustrated "If you've been listening, Leon" (~37 min.)

On other occasions, Leon displayed signs of complete engagement in the mathematics being presented by the teacher. These signs of engagement included: answering quietly to himself a teacher's question posed to another student (on two occasions); expressing surprise at the answer of another student (two occasions); and, revisiting, in conversation with Pepe (at ~22 min. and 24 min.) and with the teacher (after the lesson), a mathematical proposal he made in whole class discussion (~ 20 min.). These fluctuations in attention were one of the most visible features of his classroom behaviour during the lesson.

Leon engaged in three significant mathematical activities during the lesson:

1. Introducing a novel mathematical proposition in whole class discussion

He asked the teacher in a whole class discussion that "Couldn't a rectangle be a special kind of square?"
Leon's subsequent discussion with Pepe suggests that this suggestion was initially an impulsive statement, possibly prompted by a desire for attention. The initial statement was preceded by a direct look at the video camera and a grin to Pepe, suggesting the motivation was attention seeking. The subsequent revisiting of the proposal in conversation with Pepe suggests that the conjecture was not well thought out, but also shows Leon's willingness to reflect on a novel mathematical idea, once it has occurred to him.

Leon: Did you like my "Well then, couldn't a rectangle be a special square?" (~ 22 min.)

Leon: I don't know where I came up with that square [laughs] (~24 min.)

In the after-class discussion with the teacher, Leon did not seem to have advanced his thoughts on the idea. When the teacher asks Leon and Pepe, "Does a rectangle have four equal sides?", Pepe is quick to challenge Leon with, "Yeah, then how come that makes it a, a special type of square?" Leon repeats the same formulation that he first proposed, "Yeah, but how come if a square can be a special kind of rectangle, why can't a rectangle be a special kind of square?" Pepe replies: "Because it doesn't have four equal sides." In the very short subsequent discussion, Leon does not offer any arguments to support his position and the teacher's and Pepe's statements suggest that their purpose is to get Leon to acknowledge that while a square shares the attributes of a rectangle, the reverse is not the case (although Pepe probably does not see the distinction in those terms).

2. Assisting Pepe in constructing a triangle

Leon's lack of commitment to precision is first documented in the discussion of the homework ("Find the area of your hand") when he says, "I didn't include all those little bits." When Pepe begins constructing their triangle, Leon first says, "How do you usually make it?" (30 min.) and then "Go twenty-one centimetres straight up, go in a little bit." Pepe, however, seems committed to a careful construction, and at one point gets

annoyed with Leon's lack of care, "Leon. Make sure that, make sure that twenty-eight always stays on …lookit idiot (hits Leon's face)" (~34 min.). Under Pepe's direction, Leon holds one end of a ruler while Pepe moves the ruler in an arc, improvising the procedure for the compass construction of a triangle.

3. Conceptualising a method for finding the area of a triangle.

Leon's first insight appears to occur when he says, "You're doing [Triangle] Two? Two's like the easiest one there." Triangle Two was the only triangle to contain a right angle and whose orientation suggested that its area might be interpreted as half of the corresponding rectangle. Once Pepe has constructed their triangle, however, he asks Leon, "How do we do, how do we do that?" (~37 min.). Leon then directs him "You've got to rule it up to one centimetre things," something Pepe, at that stage, had not commenced to do. Interestingly, in a conversation with the teacher, immediately prior to this, Leon said, "I think I know" [Teacher: Do you?]. Leon: "Except if I was doing Triangle, Triangle two's the easiest one there." The fact that he subsequently directs Pepe to find the area of their triangle by constructing centimetre squares suggests that while he may have conceptualised the relationship between the right angled triangle and a rectangle, he has not extrapolated this relationship to apply for any triangle. But, importantly, he appears to suspect that this can be done. This is suggested by the statement, "There's so many other shorter ways they could have done it. (~ 38 min.). It may be that Lara provides the method at the very end of the lesson, as Leon says to her, "Well thanks, I was just about to figure that out for myself, but don't worry." (~40 min.).

If we were to characterise the nature of Leon's classroom practice on the basis of that one lesson's videotape, the resulting picture would be of a student whose level of engagement with the mathematics fluctuates frequently during the course of the lesson; an intelligent student who is attracted by big ideas and recognises the value of generalisations as mathematical tools; but also a student not inclined to precise work and who, lacking a simple generalised procedure, is disinclined to persevere with a more laborious mechanical method. Happily, the classroom videotape is not the only source of data available to us regarding Leon's classroom practice and the motivations for his actions. What additional corroborative, complementary or contradictory information about Leon's classroom practice might be provided by the other data sources available this study?

The post-lesson video-stimulated reconstruction of his classroom practice

These interpretations of Leon's behaviour and cognitive activity during Lesson 12 arose from (a) the video-stimulated post-lesson individual interview with Leon, and (b) review of the sections of the classroom video selected by Leon during this interview. Leon spent most of the interview discussing his mathematical thinking and reviewing the pertinent parts of the video. On occasions he discussed his off-task behaviour recounting each incident in a matter of fact manner [Video & Int]. For example, Leon drew attention to and briefly discussed the excerpt where he surreptitiously kicked Lara's chair even after Lara turned to him and registered disapproval (Focus 1, Table 2). Some of the interview evidence that demonstrates Leon's mathematical thinking is now provided. Notation in excerpts of dialogue: '-' represents a self-interruption and '…' text omitted for brevity, '[V~ x min.]' the class-time for the reviewed video excerpt and '[Int]' transcript from the post-lesson interview.

Leon as an active rather than passive participant in learning:

> [Int] *Leon '[In previous lessons] she's [teacher] explained how to measure the area of a rectangle and the area of a square … and through that you have to (pause)* ***adapt*** [researcher's emphasis] *it so that you can measure a triangle and other things like that'*

Leon's capacity to consider and re-evaluate statements:

[During Focus 1 Homework: What to do with the parts of squares?]

> [V~6 min] *T '… Put them together to form… yeah, to form one square'*
>
> [Int] *Leon 'I sort of thought ooh! it would be a pretty big square and then when I was thinking …* [reflected on his thoughts while doing homework the night before Lesson 12] *[about what I thought last night] perhaps ones that were really big … and the ones that that were really little … putting them together would be one square'*.

Leon's capacity and inclination to think generally rather than in terms of specific examples:

[During Focus 2 (Table 2) 'rectangles with area 100 sq. cm.']

> [V~12 min.] *Leon 'There could be heaps of different combinations'*.
>
> [Int][Leon explained why he was prompted by Earl to answer the question the teacher asked] *Leon ' … I was just saying* [to the teacher] *that there were hundreds of different combinations and I didn't expect her to ask me one of the combinations'*.

Leon's progressive thoughts leading to the conjecture that 'a rectangle is a special kind of square':

> [Int] *Leon '… I was thinking about it a lot ... I was thinking ... Mrs M doesn't know what she is talking about she's saying that a square's a- a rectangle* [V~16 min.] *it's not- a rectangle is a rectangle and a square is a square'*.

Leon ' … and then she kept explaining it [V~17 min.] *and I thought ooh! well actually a rectangle is a lot like a square and a square is a lot like a rectangle'.*

[V~18 min.][Leon is engaged with the teacher explanation]
T 'Does a square have four right angles'?
Leon [to self] 'Yes'.
T 'Are opposite sides parallel in a square?'
Leon [to self] ' Yep'.
T 'And are the opposite sides of a square equal'?

Leon '... and there [V~18 min.] *was ... she was doing a little check list … she was doing all the things a square needed to be a rectangle and they all ticked off and I thought well if a square can have all the same attributes of it as a rectangle- a rectangle has only got one less than a square- so can't a rectangle be a special kind of square? It's almost exactly the same- it's only a little bit different.'*

[V~20 min.] *Leon 'By that couldn't a rectangle be a special kind of square'*

[Int] Leon [reviewing the after-lesson discussion (of rectangles and squares) with Mrs M] [V~43 min.]
Leon 'This is like really important to me because Mrs M was taking it really really seriously and um … I think that she ... she either knew she *was wrong or she knew I was wrong. She wasn't kind of iffy about it- she* ***definitely knew*** [Leon's emphasis] ***…*** *I was pretty sure I was right …'*

Leon's progressive development of ideas about finding the area of a triangle:

Leon knew Triangle 2 [the right-angled triangle] was the easiest of the three:

[V~25min.] *Leon [to Elina] 'You're doing two? Two's like the easiest one there. It's easy!'*
[Int] *Interviewer 'How did you know- what decisions did you use to decide two was the easiest one?'*
Leon ' … the rest of them had had sloping angles at the edge of them and you can see number two … its straight … all you have got to do is figure out what a rectangle is that has those two … length and width … then you can just halve it'.

Leon indicated he continued to think about finding the area of a triangle through the lesson:

[Int] *Leon ' … later on in the lesson I asked Mrs M was number two the easiest one? She said 'yeah [re: V~36 min.] So once again that was something else I was thinking about for like the whole lesson.'*

Leon's reflections [Int 1] about Pepe and Triangle 1 tend to suggest Leon's thinking had progressed:

[Int] *Leon 'Pepe … [has] drawn up the grid and ... I didn't say anything but I thought ... you could do it quicker than that ... figure out what it the area would be fully and then halve it. ...'* [re: V~37 min.]

When asked to explain his thinking:

[Int] *Leon '... you could just figure out what it would be if it was a parallelogram ... then halve it'* [Leon sketched two triangles with a pair of congruent sides connected to make a parallelogram].
[Int] *Leon 'And I thought ... mh pretend they are the same like length and width and everything. You would figure out what it would be if it was four and because you could just trial whatever it was when it was four.'* [Leon appears to be considering a way to approximate the area of a parallelogram]

Leon's comments [above] suggest a partial rather than complete formulation of a new idea. His comments below indicate this partial formulation is rather tenuous:

[Int]*Leon 'And that*[second idea in his partial formulation above] *sort of threw me off course again- like I understood it- I didn't understand it then I understood it then I didn't understand it'*
Leon ' That was um ... pretty important … but I just lost what I was thinking.'

The evidence sited above demonstrates Leon is an independent mathematical thinker who reflects upon, evaluates, and extends mathematical ideas. The evidence strongly suggests Leon was involved in this type of higher-level generalised thinking intermittently but with sustained interest throughout Lesson 12. Leon sometimes focused on an idea central to the mathematical focus intended by the teacher but he also spontaneously focused on other mathematical ideas that were of interest to him. Leon's interview testimony in conjunction with the video he selected to support his statements draws attention to an important issue for classroom research and for teacher assessment of student behaviour; as Clarke (2001) noted, a student may be involved in cognitive activity even though his overt classroom behaviour provides evidence to the contrary.

Synthesis and conclusions

The authors have selected excerpts from their individual interpretations to illustrate the process of synthesis. Our purpose is to illustrate how additional evidence in some cases resolved our inconsistencies and in other cases still left the data open to our multiple interpretations. We discuss consistencies between the interpretations, corroborating evidence where existence of the second data source led to further elaboration of an interpretation, differing interpretations where the introduction of further evidence led to a revised shared interpretation, and opposing interpretations which even with the introduction of further evidence from Lesson 12 still led to our retention of alternative interpretations.

Taken in combination the video and interview accounts of Leon's classroom practice provide corroborative and complementary pictures of Leon as a student simultaneously engaged in off-task activities and the progressive formulation of new mathematical ideas of a generalised rather than specific nature. The addition of the student voice in the interview provided evidence of a greater depth of mathematical thinking and a higher level of selective attentiveness than was apparent by inspection of classroom video evidence in isolation. The student's coherent reconstruction of his thoughts provided detail clearly not available solely from inspection of the video.

In some cases a refined interpretation was finally shared when the data sources were considered in combination. One cited example of Leon's inattentiveness [Video Interpretation] can be attributed to Leon's focus on generalisation ('hundreds of different combinations' of dimensions of rectangles) rather than specific examples [Interview Interpretation] [Lesson 12, Focus 2]. Similarly, where the video evidence suggested Leon 'lacks a commitment to precision' (failing to count the partial squares for the area of his hand), Leon's interview testimony added additional information (he had generalised the combination of partial squares the night before). Considered in combination, the evidence suggests Leon lacks the inclination to work laboriously with specifics when he has already formulated a generalisation or he is in the process of developing a generalisation. The evidence available from Lesson 12 does not inform us about Leon's behaviour in a situation where he does not possess a generalisation and is not presently formulating one. Evidence from the other thirteen lessons may address this question.

Areas of divergence between the video and interview interpretations related to Leon's intentions: Why did Leon leave Pepe to do the triangle task almost single-handedly? [Focus 3] and Why did Leon ask the question 'if a square can be a special kind of rectangle then why can't a rectangle be a special kind of square? As the first of these questions has previously been addressed by one of the authors in another paper (drawing on synthesised data from several lessons) (Williams, 2001), the second of these questions has been selected for detailed consideration in the present paper. The video interpretation of Leon's question 'Couldn't a rectangle be a special kind of square?' as impulsive led to the addition of further evidence from the interview data. In his interview, Leon selected video of the class response to his question: and commented 'why are they laughing? I was thinking about this for ages?' Leon's revisitation of the event when he questioned Pepe is open to at least two interpretations. Leon could have been motivated by concern over the opinions of his peers about the mathematical quality of his question (Erikson, 1968) [Interview interpretation] or pride over the reception of his attention-seeking question by other class members [Video interpretation]. Leon's intentions could even be some combination of the two interpretations due to the 'fluid nature of identity' (Tierney, 2000) particularly in the case of an adolescent (Erikson, 1968). The question now arises: 'Does this unresolved difference in interpretation matter?' As portrayal of the classroom practices of the learner is central to this study, *if* Leon is concerned about the laughter of his peers in response to his question he had 'thought about for ages', this *could* reduce Leon's inclination to ask similar conceptual questions in the future. Conversely, *if* Leon asked the question to gain attention, the student laughter could increase the likelihood that he would ask similar conceptual questions in future. Knowing what motivated Leon to ask the question would inform us about the way this student constructs his classroom practice.

If Lesson 12 were the only lesson studied, this question might never be resolved but because the research design included the study of fourteen consecutive lessons we can look at Leon's subsequent (and previous) behaviour for clues as to how the reception of a very public conjecture contributed to the evolution of one student's classroom practice. This is an appropriate example with which to close our discussion: If we are to understand how classroom practices evolve then it is essential that we provide the opportunity for the voice of all participants to be heard. This involves a commitment to maximising the diversity of the data sources we access in constructing our accounts of practice. Since the interpretation of any practice will vary according to how you are positioned by it or in relation to it, different data sources will inevitably prompt the construction of 'complementary accounts' (Clarke, 2001). The challenge we confront is how best to synthesise these accounts into a portrayal of practice that will inform and improve the effectiveness of our mathematics classrooms.

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