One teacher's awareness in a mathematics classroom: towards an observation methodology

Julian Brown

University of Bristol, School of Education

Starting from the position that it is desirable for students of mathematics to develop awareness of mathematics and acknowledging that it is not possible for a teacher to access students' awareness directly, attention shifts to the ways in which teachers use their pedagogical and subject knowledge to educate awareness. Drawing on in-class observation, review of video-record and teacher interview, I report an attempt to mark instances of teacher awareness of student awareness and to trace associated decision-making relating to student attention within a mathematics lesson. I consider differences in what is noticed by observer and teacher and how this might relate to teachers' on-going development.

Awareness; noticing; teacher decisions; mathematics classroom

Motivation

The translation of an intended mathematics curriculum to one that is enacted in a classroom is informed variously by policymakers, school leaders and individual teachers (Remillard, 2005). At each stage the culture, values and beliefs of those involved will tend to influence what becomes the experience of learners in the classroom (Brown, 2017). Changes in classroom approaches, responding to curriculum modifications, prevailing professional conversations or research findings, will change experiences of both learners and teachers. One recent account of such a process has drawn out stories of significant shifts in the awareness of teachers in the classroom (Boyd, 2017; Boyd & Ash, 2017).

Mason & Spence (1999) describe how institutionalisation of knowledge, with its demand for testability, means that "expert awareness is transformed into instruction in behaviour" (p.141) rather than retaining the sense of knowledge as a state of awareness. It is surely not inevitable that the focus in mathematics classrooms is moving towards harnessing the power of educating students' awareness (Gattegno, 1971) but in making this the case we address much more than the capacity to recall procedures, as described by Hewitt:

> By educating awareness the mathematician inside a student is being educated, which would not be the case if everything were treated as if it were to be memorised. Awareness informs decisions and how to act using information which is known. (2001, p.38)

At this point it is perhaps worth identifying two different uses of the term 'awareness' in this discussion. As used in the previous quotation, I take awareness to describe a capacity to direct attention, consciously and deliberately, in response to encounters. Given the intention to educate awareness, there is a clear motivation for teachers to recognise when and how students experience the shifts in attention that indicate becoming "aware that what used to be attended to was only part of a larger whole" (Mason & Davis, 1988, p.488). There is a second use of 'awareness' in what follows, describing core actions or functions that must be present in order to learn (Mason,

2008), so that an awareness of counting squares covered by a shape might allow attention to be drawn to a definition of area and so on (Wheeler, 1975). Developing the powers to recognise these shifts of attention is problematic, since students may exhibit behaviours of a mathematician without possessing the associated awarenesses (Coles, 2016). It is, perhaps, more viable to consider shifts in the attention of students that might indicate a change in an awareness has occurred or is imminent. Coles develops the ideas of Gattegno (1971) in order to identify the nature of such shifts that might be accessible to all learners in a classroom, "noticing what is the same or different from a collection (extraction/stressing and ignoring); considering and naming both sides of a relationship (transformation/abstraction)." (Coles, 2016, p.39) The teacher who, in turn, notices such shifts may have an awareness in the moment that there is a distinction to be made in the context of classroom activity and offer something that acts as a further trigger for students.

My intention with this small-scale study (a pilot for a pilot study) was to test whether and how such triggering and re-triggering might be tracked in order to characterise teacher awareness of student awareness. This, in turn, might provide a structure through which to explore differences in experiences of the mathematics classroom during a conscious and deliberate change in teaching approach.

Design

Becoming aware of our own awareness is, in itself, a discipline (Mason, 2002), requiring us to observe ourselves in action. Accessing my own awareness, becoming an observer of my own observations, does not come easily. Yet it is by developing my awareness of my awareness that I become more sensitised to how awareness might be developed in students (Watson & Mason, 2007). The barrier to accessing awareness in others is not one of discipline; rather, it is just not directly available to me. I must then identify that with which I can work. In the classroom as an observer, I can give attention to what I observe in the behaviours of others, and to my own awareness, observing what I as the observer am taken by in the moment. After the event, I can give attention to what I hear in descriptions of episodes from the lesson as told by participants, (the teacher only, in this case) and to changes in my own awareness as I review a video record of the lesson. These descriptions occur in two modes: accounts-of, which aim to capture the narrator's telling of what they have observed without entering into overt interpretation, and accounts-for, which relate interpretations to what was seen, trying out possible meanings and explanations (p.40).

I observed and recorded a single 45-minute lesson with a first-year A-level mathematics class in a Sixth-Form College, working on the calculation of measures of location and spread for data sets using a graphical calculator. In the lesson, I made field notes (giving some insight into the subject of my own attention in the lesson) and used a single, fixed video camera to record the lesson. The field-of-view encompassed the whiteboards and projector screen and most of the students and their desks. A few desks were not in the field of vision, allowing accommodation of a student who, whilst consenting to be part of the data collection process, declined to appear in a video recording.

Shortly after the observation, I generated an initial account-of the lesson using my field notes. Only after this did I transcribe the video record, allowing me to compare the detail extracted from repeated viewing of the video with the notes captured in the moment. The transcript informed a subsequent one-hour interview with the teacher, in which the teacher's recollections were put alongside episodes

selected from the video record. The teacher's accounts-of and accounting-for these episodes was captured as an audio recording, itself transcribed and incorporated into a thematic analysis of behaviours that might provide routes into tracking awareness.

Outcomes

For the purposes of this report, I will focus primarily on observations made with and without the use of video. Unavoidably, my field notes captured a small subset of what was apparent in the video transcription. As an observer in the classroom, I was mindful of the lesson being recorded so, in this phenomenological approach, these notes have significance in demonstrating where my attention was directed and support me in educating my own awareness as an observer. A comparison of my initial account and the full transcript suggested that my awareness was largely of transitions and I was much less mindful of noting responses from students to individually directed, closed questions. Absent from my field notes completely were instances when a student offered a response to the teacher in response to a direct question (as opposed to the teacher directing a question to the entire group). Instances of the student asking for help in response to the question or where no verbal response was noted each appear in my field notes, but I did not record instances of the teacher rephrasing/extending students' comments although each of these was strongly represented in the analysis of the video footage.

These observations suggest that I as an observer in the classroom was focused strongly on behaviours of the teacher and, particularly, with the words used by the teacher. My hypothesis is that my attention was taken by the teacher's decision making, looking for critical events that might indicate a shift in their awareness. When transcribing the video record, this was mitigated by the discipline of capturing the totality of utterances that could be discerned and the opportunity to review the recording many times. Through this process, it was possible to attune attention to different aspects in turn: teacher utterances, student utterances, teacher placement in the room, direction of verbal and non-verbal transactions.

In analysing the video transcript for shifts in attention, I sought to identify consecutive behaviour-events (observable actions) that suggested to me a transition in intention, such as a decision to change what would be offered next or to focus attention on an individual or a specific aspect of the object of the class's attention. Consideration of these behaviour-events led to identifying a set of modes in which they may be seen as suggestive of particular awarenesses. Those originating with the teacher are shown in Table 1, below, with illustrative examples of observations made. One such example occurred when the teacher was working with the class on calculating the standard deviation of a pair of values. Having written "$\Sigma\ x^2 =$" and "$\bar{x} =$ " on the whiteboard, the teacher (denoted here by T) goes on to work with one student (denoted here by H) to develop the calculation. The transcript has been tidied up slightly, removing hesitations to ease reading. In this, text shown as ((xxxx)) indicates vocal sounds other than speech, {{xxxx}} gives a description of activity other than speech and single square brackets indicate overlapping speech.

23:16	T	We're going to work out what *n* is. {{T writes *n*=}}. And now I'm going to work out what x-bar is {{T writes $\bar{x}$ =}} and that's all I need, really. OK, so first of all the sum of x-squareds. So I've got to square each of those and add them together, so what might that look like, H? Just looking on the left-hand side first of all. We've got three and we've got eleven, if I square those, what will, what will both of those numbers squared be?
23:45	H	I don't know. Nine and a hundred and twenty-one?

23:49	T	[You do know! You just said it, it's absolutely right!
23:49	H	[((Laughs)) I know.
23:52	T	So the sum of x-squared is nine and a hundred and twenty-one. And add them together, what do you get?
23:56	H	130 ((Laughs))
23:58	T	130, so the sum of x-squareds is a hundred and thirty. {{T writes 130 beside $\Sigma x^2 =$}} You just multiply… I'll write it down here. {{T erases the 130 beside $\Sigma x^2 =$}}. So three squared {{T writes 3^2}} plus eleven squared {{T writes $+11^2$}} which is nine plus a hundred and twenty-one {{T writes =9+121}}, a hundred and thirty {{T writes =130}}.

At 23:58 it can be seen that the teacher removes a numeric value from the board (the sum of the squares of the two values) and replaces it with a set of stages in the calculation. I have taken these behaviours as an indication of a shift in the teacher's awareness of the extent to which student H is applying a process already introduced. I have then interpreted the behaviours as suggesting an awareness in the teacher of a (potential) confusion for learners based on assumptions about their use of a mathematical process. This interpretation was tested in a subsequent interview with the teacher, not considered here.

Mode	Behaviour and subsequent event noted	Suggestive of awareness of…
Teacher with Course	Teacher introduces vocabulary ("x-bar"); students incorporate vocabulary into classroom discussions.	A need to transmit 'arbitrary' content.
	Teacher (re-)directs attention to a particular feature; e.g. student highlights a mismatch with the expected outcome.	Value in reducing complexity / focusing on particular features.
	Teacher shares answers to questions set for individual activity; some students check their answers and react; some students ignore the answers and continue with their activity.	Value in students attending to a process rather than an outcome.
	Teacher makes reference to exam context / process; students act on the instruction.	Motivation derived from exam performance.
Teacher with Group	Teacher states and immediately repeats procedural instructions (for use of calculators); students follow instructions at different rates.	Limitations of verbal transmission of 'arbitrary' procedure.
	Teacher invites student feedback ("Is anyone not happy with that?"); silence.	Students progressing at different rates.
	Teacher speaks and creates a transition ("Moving on, then…"); students look at the teacher.	A need to collect attention before transmitting further information.
	Teacher asks a question to the whole group; a student offers a response; the teacher validates / challenges the response.	Drawing attention to key elements of the structure of a mathematical process.
	Teacher modifies what has been written on the board, (change in the structure of the recording); teacher continues from the new starting point.	(Potential) confusion for learners based on assumed stages of processing.
	Teacher gives an instruction for whole-class activity that creates a space for individual / paired work ("Have a go at these three…"); teacher attends to feedback at the level of the class group.	Value in addressing points of confusion before introducing new instructions or information.
Teacher with individual	Teacher moves around the classroom and checks on the status of students (the displays of individual calculators); student asks the teacher a question when the teacher approaches.	Possible barriers to students raising concerns.
	Teacher asks an individual student a question; student does not respond, and teacher speaks next.	Affect becoming a barrier for the student.
	Student asks teacher a question about a next step; teacher addresses a specific issue with student and/or the group.	A need to keep students' attention coincident as a group.

Table 1: Teacher-driven modes of behaviour-events suggestive of awarenesses

Having identified that my attention during the observation was largely on the teacher and teacher-led interactions, I repeated the process leading to Table 1 but with a focus on behaviours suggestive of awareness in students. The outcomes are presented in Table 2. In this case, classifying sets of behaviours with modes of interaction was less helpful, since the examples all arise in response to a behaviour-event initiated by the teacher.

Preceding behaviour noted	Behaviour noted	Suggestive of awareness of…
Teacher introduces vocabulary.	Students incorporate vocabulary into classroom discussions.	A need to absorb 'arbitrary' content.
Teacher (re-)directs attention to a particular feature.	Student highlights something which was not what they expected.	A gap in understanding. a need for accuracy.
Teacher shares answers to questions set.	Students ignore the answers provided.	Value in working through the activity for oneself.
Teacher makes reference to exam context / process.	Students act on the instruction.	Motivation derived from exam performance.
Teacher invites student feedback.	Silence.	A gap in understanding; a concern about offering an answer.
Teacher gives an instruction that generates immediate feedback.	Students offer responses.	Value in testing current understanding.
Teacher speaks and creates a transition.	Students look at teacher.	Value in attending to the expert.
Teacher moves around the classroom.	Student asks teacher a question when teacher approaches.	A gap in understanding; a need for accuracy.

Table 2: Learner behaviour-events suggestive of awarenesses

Discussion

Reflecting on the similarities and difference between my initial account-of the classroom episode and the process / outcome of transcribing the video record has provided a mechanism for a deliberate process of making myself open to see more of some of the things I had not seen in the moment and, perhaps, less of some of the things that are not pertinent to this enquiry. This, in itself, is a shift in awareness. The process of reflection undertaken by and with the classroom teacher has the potential to initiate a similar type of shift. It is the capacity to direct attention, consciously and deliberately, in response to encounters in the moment, that I am labelling 'teacher awareness'. Undertaking a similar process of review with one or more of the students in the lesson would be desirable in order to put their account alongside my interpretations, but is less accessible given the lack of precedent for the equivalent of the professional conversation with the teacher. Further consideration of how to explore these interpretations is needed.

The next stage of enquiry will be to repeat the process of observation and accounting of and for with the same teacher in order to look for differences in how attention is directed in response to what is noticed. Analysis of the teacher interview, not discussed here, makes it clear that these interpretations are usefully grounded in the re-telling of the teacher. It is perhaps worth noting here that the teacher reported this process to have been "enjoyable" and "challenging"; this first cycle was coloured for the teacher by the newness of watching themselves on video and hearing their interactions so that their consideration of awareness was just one aspect amongst many (including a more detailed consideration of the mathematics in the lesson).

The themes arising from the video transcript give some encouragement to look at characterising behaviours as suggestive of particular awarenesses. Given the emergent focus on the role of teacher decisions, links with models developed in this area (such as Westerman's model of expert teachers' decision making (1991)) might be possible, although further data will be needed to support any such attempts. The movement shown in Tables 1 and 2 from observed behaviour-events to suggested awarenesses was here informed by a resonance with my accounts of my own classroom practices, drawing parallels with decision-making points. Developing particular questions that guide the identification of such movement will be a valuable step in progressing towards an observation methodology and analytic framework based on behaviours suggestive of shifts in awareness.

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