Characterising patterning of teacher-learner interactions in mathematics classrooms

Julian Brown

University of Bristol

Deliberate development of our practices, in and out of the classroom, is supported by explicit awareness of possibilities in the moment, expanding possibilities for action. My role as a mathematics teacher educator involves working alongside teachers as they work on their own awarenesses. I am interested in how classroom observations might be used as a mechanism to follow and support development of the awareness of awareness. This report makes use of observations of sequences of lessons taught by two different, experienced teachers of mathematics to consider possibilities for characterising particular teacher-class environments and, hence, to identify shifts in these environments. Consideration is given to how such mechanisms might act as tools for development of in-the-moment awareness for practising teachers.

Keywords: teacher attention; teacher questioning; awareness; secondary mathematics classroom; observable behaviours.

Context

A significant part of my work as a mathematics teacher educator involves my observing other mathematics educators in the classroom and being part of subsequent conversations in which those teachers reflect on their practice. Developing my own practice in relation to such observations and feedback is, then, of great significance to me (Brown, Brown, Coles & Helliwell, 2019) and I am drawn to consider what it is possible for me to observe in a classroom. Such considerations must, for me, include a focus on what it is *possible to observe* and what it is possible *for me* to observe. I have an interest in teachers' awarenesses in the classroom, on both in-the-moment awarenesses (what I associate with Mason's (1998) description of awareness-in-action, the ability to act in the moment), and a teacher's capacity to re-enter and interrogate their awarenesses (my sense of Mason's awareness-in-discipline, an awareness of awareness-in-action), and of my own awarenesses in working with teachers working with their awarenesses (my sense of Mason's awareness-in-counsel, an awareness of awareness-in-discipline). I hold that seeking access to what is 'in the head' of another is attempting to observe the unobservable, so that attempting to observe directly the awareness of another is seeking the unattainable. In order to stimulate conversations with a teacher following a classroom observation, it is possible to select any number of observable behaviours. (As just one example, the Secondary Teaching Analysis Matrix (Gallagher & Parker, 1995), developed by a group of ten universities in the 1990s for analysis of science and mathematics lessons, lists twenty-two categories of teacher/student action, such as use of examples; teacher questions; student questions; writing and representation of ideas.) Given my position that I cannot observe awareness directly, I am seeking observable behaviours that are effective in prompting a teacher's reflection on their doings in a lesson that have been

made possible through awareness-in-action. In his inquiry with students learning English as an additional language in the context of primary school mathematics, Barwell (2003) analyses participants' *attention* through application of conversation analysis, stating that "the explicitness of [participants'] attention… provides a basis for analysis, since analysts can observe attention just as much as the participants" (p. 37). Bearing in mind the *post hoc* nature of much conversational analysis, this report explores possible markers of attention that can be reflected back to the teacher in a conversation that might follow immediately from the lesson, i.e. that are accessible without extensive intermediate analysis.

The second consideration identified above, what it is possible *for me* to observe, arises from a sense that what I observe says as least as much about me as a researcher as it does about the situation being observed. I read this sense in the wisdom captured by Maturana (1987), that *everything said is said by an observer*. In their study of characteristics of pedagogy, also not open to direct observation, Reid, Savard, Manuel & Lin (2015) make use of Maturana's insight to resolve the conundrum of observing the unobservable:

> Pedagogy cannot be studied using approaches that involve external observers, as they have no access to what is implicit to the teachers themselves. However, by positioning the teachers as observers, one gains insight through what they observe and how they observe it into the implicit criteria that guide their observations. (p. 3157)

The role of teacher-as-observer highlights the significance of the teacher's voice. Reid et al. act on this realisation by asking teachers to make video recordings of themselves teaching and to then comment on these video recordings. I have reflected elsewhere on methodological implications of delays between teachers recording and reviewing their teaching practice (Brown, 2018), in the light of which I am interested in other possibilities for acknowledging the co-implication of observer and observed.

A search for observable markers of shifts in attention

In looking for and at lesson elements to observe, my interest is, then, in exploring observable behaviours that act as possible markers of shifts in the teacher's attention during lessons, in order to inform conversations in which the teacher reflects on shifts in awarenesses. Such shifts might occur within a single/ lesson, or might emerge over sequences of lessons, as a teacher becomes explicitly aware of different aspects of their pedagogical approaches. There have been a number of large-scale research projects that have considered whether it is possible to characterise lessons on various scales, including attempts to find signatures of particular classrooms on a national scale, such as the Characterising Pedagogical Flow (CPF) work of Schmidt et al. (2002), the Third International Mathematics and Science Study (TIMSS) Video Study (Hiebert et al., 2003) and the Making Connections learners' perspective projects (Clarke, Emanuelsson, Jablonka & Mok, 2006), concluding that it is more practical to look at sameness and difference across these sets of lessons than to find meaningful characteristic signatures at this level of analysis. Anecdotally, however, there is a sense from working in schools that we might be quite successful in identifying which of our colleagues taught a given lesson that was described to us and this experience holds out the possibility of finding observable behaviours that might capture something of any particular teacher's lessons. If this were possible, it would provide a frame of reference in which to identify points of difference from characteristic practices, which might then be followed up with the teacher. Stigler & Hiebert (2009)

provide one possible mechanism for such a characterisation with their representations of lesson patterns, i.e. the sequence and balance of lesson components across groups of lessons. One possibility explored here is application of this same mechanism to analysis of individual lessons, in order to test the possibility that it might allow interrogation of points of movement away from a commonly observed lesson signature.

A second possible mechanism for representation shown below arises from use of questions as a framing, an observable behaviour which might open possibilities of identifying points of decision during the lesson. Patterning in the use of questions might be investigated through representations of *question classification*, using some suitable framework for analysis. This analysis might in turn provide markers of shifts through noticeable changes in mode of question, patterning by *elapsed time in the lesson*, which might show contrasts between density of interactions, and *patterning of turns* between learners and teacher, which might show the teacher intervening to redirect learner's attention.

Data available

The data represented here come from two sets of non-consecutive lessons. The sets of lessons were taught by experienced teachers of mathematics, in two different secondary schools in England. In the case of Teacher 1 (T1), both video recordings and field notes of questions asked by the teacher in a set of lessons with a Year 10 class (ages 14 and 15 years) were available; in the case of Teacher 2 (T2), transcripts of lessons with a Year 7 class (ages 11 and 12) were available, with partial lesson timings.

Lesson pattern codes

Using as a starting point the sets of pattern codes identified by Stigler & Hiebert (2009) from their analysis of mathematics lessons in various countries, transcripts of the two sets of lessons examined here were used to establish suitable codes, which were then used to build up representations of complete lessons. These are shown in Figure 1, with elapsed time in minutes shown on a rising vertical scale. Where time data was incomplete in transcripts of lessons with Teacher 2, durations were inferred from the transcripts; whilst this approach can give only an approximation of the timings of the lesson, it has been used to generate representations of the three lessons in the set, since the purpose of the current investigation is to explore methodological possibilities rather than to focus on the detailed analysis of individual lessons.

There is a significant degree of variation between lessons in each set, as well as between sets. Each lesson has more than one phase of students working individually or in a group (shown as yellow) and time spent discussing solution methods (shown as green). Only in Teacher 2's lessons are there phases of highlighting and summarising key points (shown as dark red). Time spent marking work (bright red) was present in each lesson with Teacher 1 and in only one lesson with Teacher 2.

The absence of strong signatures of each teacher in these representations suggests that lesson pattern codes are not, in these cases, a viable mechanism for identifying points at which a teacher steps outside of a usual lesson pattern. I do, however, imagine that such a representation would still provide a stimulus for the teacher to recall their awarenesses during the lesson, not least because it provides an account of what the observer has identified as points of transition in the lesson.

Figure 1: Lesson pattern codes for sets of lessons with each of two teachers. Vertical scales indicate cumulative elapsed time in the lesson, in minutes. The upper row represents lessons with Teacher 1 and the lower row with Teacher 2.

Question patterning

A framework for coding questions asked in each lesson was taken from Mason's four-way classification (2002), comprising controlling questions (CQ), cloze technique (CT), genuine enquiry (GE) and meta-questions (MQ), along with a fifth class, other management (OM), designed to capture utterances which were directed at managing the classroom environment. The interpretation of these codes is taken from that used in a larger study (Brown, 2019). Codes were applied to all questions that had been noted in the lesson transcripts. I found the lack of complete time codes with the transcripts for lessons 2 and 3 with Teacher 2 to be too significant to interpolate to the level of detail required. Question codes have been plotted in Figure 2 with horizontal axes showing elapsed time, in minutes. Each of the grey strips overlaid on these plots represents an interval of five minutes.

Whilst only four of the six lessons could be time-coded in this way, it is striking that the lesson with Teacher 2 has a much greater space without questions being asked in the context of whole-class discussions. A comparison with Figure 1 shows that this part of lesson 1 for Teacher 2 was taken up with students working individually or in groups. In contrast, lesson 4 for Teacher 1 indicates that questions (largely, controlling quesitons) were still being asked during several phases of students working individually or in groups. One reading of this is that the teacher continued to direct students' attention as a whole class whilst they worked

individually or in groups. Both teachers made little, if any, use of cloze technique questions and there is a marked difference in the frequency of metaquestions used in the lesson with Teacher 2 and any of the lessons with Teacher 1.

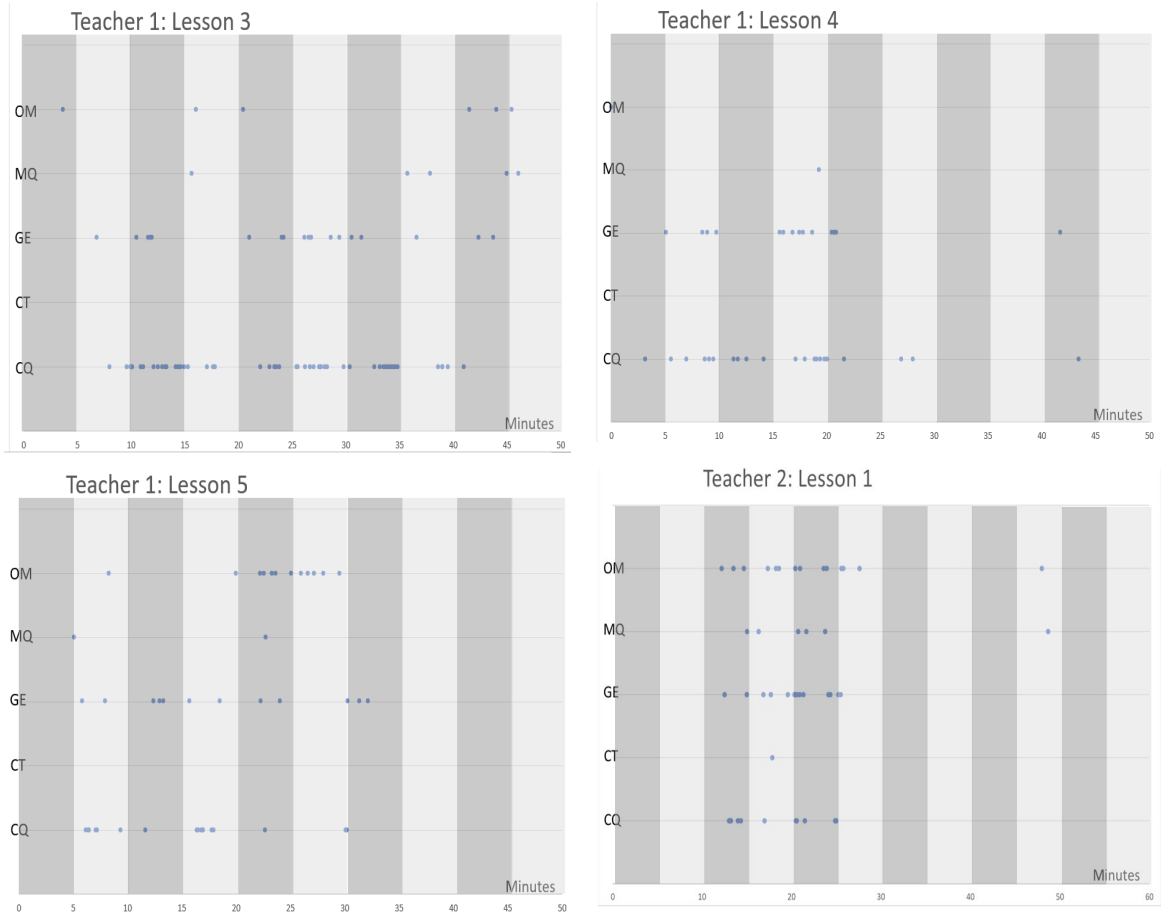

Figure 2: Question codes for sets of three lessons from Teacher 1 and one lesson from Teacher 2. In each case, the horizontal axis represents elapsed time in the lesson, in minutes.

Even given the features noted, the variation seen between lessons with this representation again suggests that, whilst attention is drawn to new features of each lesson individually (what, for example, triggers the use of meta-questions, which appear rarely for Teacher 1 and more frequently for Teacher 2?), establishing a signature of a typical lesson that allows differences to be highlighted does not seem plausible on the basis of this limited set of data. One possible interpretation is that a larger set of lessons is required for such a signature to emerge.

Moving to shifts

Whilst neither representation is sufficient to establish characteristic patterns for each teacher from these small data sets, sharing with teachers (the participants themselves and other mathematics education researchers) has highlighted a potency in stimulating questions about mathematical behaviours in the lessons. The immediate value of these representations might, then, lie in their capacity to act as stimuli for a teacher's recall. Using the representations in this way has also raised questions of how the very process of teachers reflecting on lessons provokes shifts in their awareness. A process of repeated observation and reflection would then perturb any characteristic signatures that might otherwise be discerned over time. Future work will, therefore, be on use of such presentations of observation data to prompt and probe the observations teachers make about their own awarenesses in lessons they have taught.

References

Barwell, R. (2003). Patterns of attention in the interaction of a primary school mathematics student with English as an additional language. *Educational Studies in Mathematics*, *53*(1), 35-59.

Brown, J. (2018). A comparison of approaches to stimulated recall interviews with mathematics teachers in order to identify shifts in attention. In E. Bergqvist, M. Österholm, C. Granberg, & L. Sumpter (Eds.), *Proceedings of the 42nd Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 2-179). Umeå, Sweden.

Brown, J. (2019). Observing teacher questioning and teacher attention in a mathematics classroom. *Proceedings of the British Society for Research into Learning Mathematics*, *39*(2). Retrieved from https://bsrlm.org.uk/wp-content/uploads/2019/09/BSRLM-CP-39-2-3.pdf.

Brown, J., Brown, L., Coles, A., & Helliwell, T. (2019). Learning to teach mathematics: The lesson de-brief conversation. In *International Handbook of Mathematics Teacher Education: Volume 2* (pp. 85-108). Rotterdam: Brill|Sense.

Clarke, D., Emanuelsson, J., Jablonka, E., & Mok, I. A. C. (Eds.). (2006). *Making connections: Comparing mathematics classrooms around the world.* Rotterdam: Sense Publishers.

Gallagher, J., & Parker, J. (1995). *Secondary teacher analysis matrix (STAM)*. East Lansing, MI: Department of Teacher Education, Michigan State University.

Hiebert, J., Gallimore, R., Garnier, H., Bogard Givvin, K., Hollingsworth, H., Jacobs, J., ... & Manaster, A. (2003). *Teaching mathematics in seven countries: results from the TIMSS 1999 video study*. Retrieved from https://research.acer.edu.au/timss_video/5/.

Mason, J. (1998). Enabling teachers to be real teachers: Necessary levels of awareness and structure of attention. *Journal of Mathematics Teacher Education*, *1*(3). 243- 267.

Mason, J. (2002). Minding your Qs and Rs: Effective questioning and responding in the mathematics classroom. In L. Haggerty (Ed.) *Aspects of teaching secondary mathematics: Perspectives on practice* (pp. 248-258). London: RoutledgeFalmer.

Maturana, H.R. (1987). Everything said is said by an observer. In W. Thompson (Ed.), *Gaia: A way of knowing* (pp. 65-82). Hudson, NY: Lindisfarne Press.

Reid, D., Savard, A., Manuel, D., & Lin, T. (2015). Québec anglophone teachers' pedagogies: Observations from an auto-ethnography. *CERME 9 - Ninth Congress of the European Society for Research in Mathematics Education, Feb 2015* (pp. 3115-3121). Prague, Czech Republic.

Schmidt, W. H., Jorde, D., Cogan, L. S., Barrier, E., Gonzalo, I., Moser, U., ... & Prawat, R. S. (2002). *Characterizing pedagogical flow An investigation of mathematics and science teaching in six countries*. Dordrecht: Kluwer Academic Publishers.

Stigler, J. W., & Hiebert, J. (2009). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York: Simon & Schuster.