Trying to improve communication skills: the challenge of joint sense making in classroom interactions

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In this paper we examine the efforts of one teacher working to improve her students' communication skills as part of a collaborative project with teachers and teacher educators/researchers. The paper reports on a project meeting where the teacher presents a short video clip featuring two student explanations. Yet only one explanation is treated in the lesson as an example of good communication. Following discussion and multiple re-viewings of the video clip in the meeting, what counts as good communication is critiqued by the teachers. Driven by an emphasis on the two-way nature of communication, the need for joint sense-making between teacher and students, and privileging explanations that communicate mathematical understanding, alternative teacher actions are suggested during the meeting that are related to how different teachers interpreted the students' explanation.

Keywords: classroom interaction; sense-making; video-based professional development; mathematical communication; explanations.

Introduction

Students explaining mathematical ideas, relationships and reasoning is something that students often find difficult to do, and teachers often find difficult to support students to do (Michaels & O'Connor, 2015). There is now a wealth of literature and research detailing the different ways in which teachers can support students in their communications skills in mathematics including through their questioning (e.g. Boaler & Brodie, 2004), how they follow up on students' answers (e.g. Lim, Lee, Tyson, Kim, & Kim, 2019) and by giving students time to think (Ingram & Elliott, 2016; Sohmer, Michaels, O'Connor, & Resnick, 2009). One of the challenges is the need to provide students with the opportunities and support to give explanations whilst at the same time ensuring that the content of what students say supports the learning of all the students within the classroom, the difference between the interactive and dialogic aspects, and the epistemic aspects (Erath, Prediger, Quasthoff, & Heller, 2018). Whilst explanations can support students in developing new understandings of mathematical ideas at the same time as accomplishing linguistic goals (Moschkovich, 2015) by offering students opportunities to use mathematical terminology in meaningful ways.

Taking mathematical explanations to be "giving mathematical meaning to ideas, procedures, steps , or solution methods" (Hill, Charalambous, & Kraft, 2012, p. 63) an issue arises where ambiguities in the mathematical meaning of what a student is saying arises. In this paper we focus on a particular challenge that teachers can face when offering students the opportunities to explain their thinking – where the teacher has difficulty making sense in the moment of what the student is saying. These contingent moments place significant demands on teachers' subject and pedagogic content knowledge (Rowland, Thwaites, & Jared, 2015) both in terms of interpreting what students are saying as well as making the decision of whether pursuing the line of thinking will be beneficial to other students. At these points in time teachers have a range of talk moves or strategies (Howe, Hennessy, Mercer, Vrikki, & Wheatley, 2019; Michaels & O’Connor, 2015) which they could use such as revoicing (O’Connor & Michaels, 1993), asking the student to elaborate on what they’ve said, asking other students to elaborate or build on what has been said, or asking other students to agree or disagree or contrast with what has been previously said, though often the most common reaction is to move on to a new discussion. Where a teacher has difficulty making sense of what students are saying, it can also be difficult for teachers to make connections with other student contributions or the original task, or to support the student in improving the clarity of what is being said.

The interactional perspective taken in this paper (Blumer, 1969; Ingram, 2018) emphasises the situatedness of explanations within the context in which they occur. What counts as an explanation, and what counts as a mathematical explanation depends upon how they are treated by teachers and students as they interact (Ingram, Andrews, & Pitt, 2019) as well as the sociomathematical norms established in the classroom (Yackel & Cobb, 1996). This paper considers an example where an explanation is offered, and therefore is treated as an explanation by the student, that is not treated by the teacher in the moment as having mathematical meaning to the task being considered. This type of situation is significant in that it highlights the distinction made by Erath (2016) between teachers offering opportunities for students to give mathematical explanations, and teachers giving support for students to give mathematical explanations.

Discipline of Noticing

The way of working with teachers described in this paper is based on Mason’s Discipline of Noticing (2002) which combines reflective practice and action research. From this perspective, teachers shape their own professional development by reflecting and acting upon their own practice with a supportive group. The principle underlying the professional development is that by teachers noticing aspects of their own practice, they become sensitised to noticing this aspect in the future which opens up opportunities for acting differently (Mason, 2012). When working with videos of teaching, the practice of giving *accounts of* before *accounts for* is key to reflecting on practice using what is actually happening in classrooms, rather than our interpretations and impressions of what is happening. *Accounts of* describe the video clip in a way that others can recognise, whilst *accounting for* includes interpretations, explanations, justifications or criticisms (Mason, 2002, p. 41).

Method

Anna shared the clip of her teaching during a meeting involving 5 mathematics teachers and 2 mathematics teacher educators/researchers. The meeting used the CoNCAV (Collaborative noticing through close analysis of video) approach based on Mason’s Discipline of Noticing (Mason, 2002, 2012). This involves teachers sharing and discussing a 2-3 minute video clip, chosen by them, of their own practice. The meetings involved the analysis of the clip from the teachers’ own practice, focusing first on *accounts of* before *accounting for* (Coles, 2013) what is seen in the clip, and then considering alternatives for acting differently in the future. The meeting reported on is this paper occurred half-way through the second year of a two-year project in which a group of mathematics teachers from the same school met 6 times a year.

The data for our analysis in this paper are the verbatim transcripts of the meeting and Anna’s lesson, with both teacher and student voices being recorded in the transcript as well as there being a record of what was displayed on the board in the classroom. Anna's clip came from a Year 7 class (students typically aged 11 to 12 years) in England. In order to reflect the close collaborative nature of the project between the teachers and the researchers we have used the teachers' and researchers' own words as often as possible in the analysis, and furthermore we make no distinction between the contributions of teachers and researchers. We mark out instances of talk from the lesson transcript by including these as extracts, whereas talk from the meetings is generally included within the body of the text unless we are offering an example of an extended conversation from the meeting. Across the project as a whole, all of the meetings were audio recorded. In addition, the teachers shared with the researchers the video from all lessons they recorded, and not just those from which they chose clips to share with the group.

Results and analysis

The Clip.

The CoNCAV approach starts with the teacher presenting the 2-3 minute clip they have chosen for discussion. Anna introduced her clip by commenting: "*This is Year 7 and they've done some work, previous lesson, on sequence, just term to term rule of sequences and I've just put a picture up on the board of pentagons linked together like a matchstick pattern. They had to find the next couple of patterns and then the 12th pattern*." (See Figures 1 and 2).

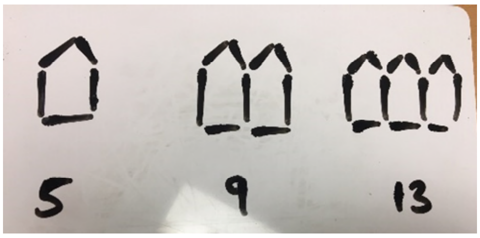

Figure 1: Matchstick pattern

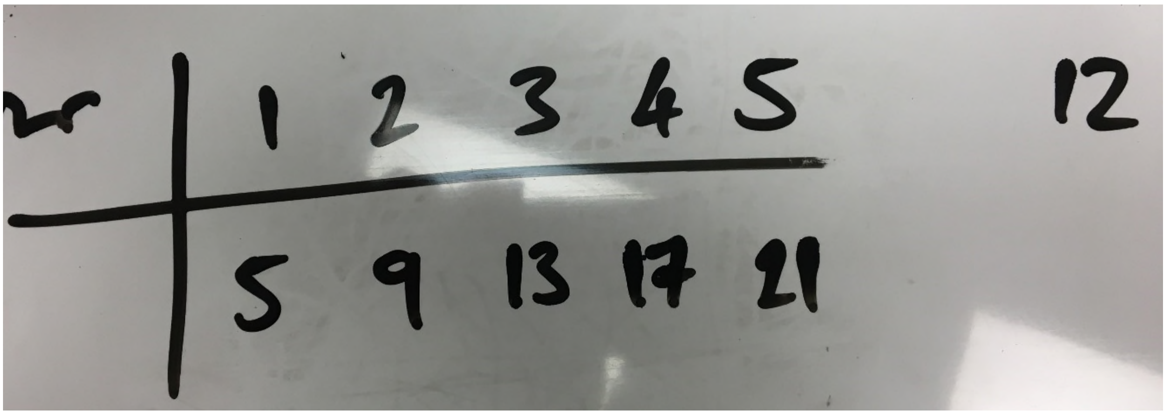

Figure 2: Number pattern

Typically the next step in the CoNCAV approach is for the teacher to give an *account of* the clip. Anna had been "*trying to improve their communication skills*" and one way she reported doing this was by leaving students time, or pausing, and her attention during the discussion following the first viewing of the clip was how she had been "*doing displacement activities. You know what people do when you don't like pauses? And, so I wrote on the board when the boy was thinking, to give people thinking time. So, rather than them feeling so much on the spot, I busied myself doing something on the board, so they could buy a bit more time*." She described the clip as showing improvement in the students' communication, but reported that Sam "*knew exactly what he was doing, he just wasn't quite clear enough*".

A critical feature of the CoNCAV approach is the re-viewing of the video clip. After the second viewing of the clip the discussion focused on Sam's explanation, given in Extract 1, of why there will be 49 matchsticks in the 12th picture.

25	Anna:	so, um, why is it 49 then, Sam? Can you explain in your own words, please?
…		
39	Anna:	how do you get from five to nine? What are you adding?
40	Sarah:	four, four, four, four
41	Anna:	what are you adding?
42	Sam:	Four
43	Anna:	yeah. Are you adding four there as well?
44	Sam:	yeah
45	Anna:	yeah. Are you adding four there as well?
46	Sam:	yeah
…		
58	Sam:	you times four by seven
59		(0.8)
60	Anna:	why?
61	Sam:	you add twenty eight to it and then that
62	Anna:	oh!
63	Sam:	no, 'cause if you times four by seven, we have seven until we reach like the number at the top, seven till we reach 12, and then ;cause you're adding four every time, it's four times even, like that, so that's 28.
64	Anna:	so four times seven is
65	Sam:	twenty eight
66	Anna:	so you think the answer is 28 sticks do you?
67	Sam:	um
68	Anna:	no, we agreed there was actually 49 sticks
69	Students:	yeah
70	Anna:	yeah
71	Sonia:	um, you do, um and so it's plus four each time
72	Anna:	mm
73	Sonia:	so you do twelve times four plus one, because twelve times four, no four times twelve is forty eight, so you have to plus one. Or if you do that, because it's just one more than the actual four times twelve, so you go four, eight, twelve, so it's four, nine, seventeen
74	Anna:	okay
75	Sonia:	so I think Sam means (0.3) you have to have twenty eight more sticks.

Extract 1: Sam explaining why there are 49 matchsticks in pattern number 12

Anna stated at the beginning of the meeting that she chose the clip because although Sam had got the right answer he had not communicated his ideas clearly. This meant that during the interaction with

Sam in the lesson, she had "*persevered with him, because I knew that, really, he knows what he was doing and after a bit of thought he could do it*", but she also reached a point where she "*lost the will to live and moved to Sonia*". Following this second viewing of the clip Anna acknowledged that in that moment, during the lesson she did not know "*exactly what he meant*", and was not aware that his reasoning was valid, that "*he had got the right answer*". Thus Sam did not communicate what he was referring to when he said that there were 28 matchsticks and he "*wasn't able to just argue that point*" in turn 67.

The discussion then turned to possible actions Anna could have taken instead of moving to Sonia, and this represents the shift in the CoNCAV approach from focusing on the specific case of the clip to considering alternative ways of acting. Anna began by suggesting that she "*should have stalled for a bit longer and gone and watered the plants or something and let him think about it and then he could have explained better.*" Laura then suggested that another possibility would be to use Sonia's explanation of what Sam means given in turn 75. This strategy involves treating Sonia's explanation as a model of "*a clear explanation*" and then asking Sam if "*that is what you meant*". Yet this raised another issue for Laura and Freya as illustrated in Extract 2.

Laura:	But, giving him that ... yes, getting him to then be able to do that next time is probably going to be hard, because he's just gone, "Yes, yes. What she said".
Freya:	Yes, that thing of making him say it, exactly what he meant, then or even talking a bit about, "Why didn't I understand when you were saying it, but I've understood when Sonia has? What's different about the way she explained what you meant?
Anna:	I know. That's why we keep plugging away, don't we?
Freya:	Yes, but if they're let off the hook by just letting someone articulate explain it and they get to go, "Yes, I meant that," does that actually make him any more able to do it next time?
Anna:	No, it doesn't. So, tomorrow I'd put him on the spot again. We'll do another starter similar to that and I'll ask him again.
Freya:	I think some explicitly need teaching how to articulate something like that, don't they?
Anna:	Yes
Freya:	Like you were saying you could have gone and watered the plants instead, but I don't think he would have got there, because he doesn't actually know how to do it any differently. He was saying it the best he could. It was only when he heard her that he could see how it could be said.

Extract 2: Developing students' explanations

The challenge of trying to improve students' communication skills has become multifaceted for these teachers, involving giving students time to think and to articulate their explanations, using students' explanations as models, but also explicitly teaching students what it means to articulate an explanation. Yet so far, the discussion has not considered the mathematical nature of the explanations being given. This shifts when Dave contrasts Sam's and Sonia's explanations in Extract 3.

Dave:	although, I would say, out of the responses, he's got the clear insight of the nth term of arithmetic progression, so the a plus n minus 1 d. ((a + (n-1)d))
Anna:	well, yes actually
Dave:	whereas, some of the others are saying 'right, I can see the formula that I've got to multiply by four and add 1' without any idea of actually where that's coming from.

Extract 3: Contrasting the mathematical nature of students' explanations

The contrast becomes between an explanation that reports "*the calculation that I did*" and explanations that focus on the mathematical meaning behind finding the nth term. This requires the teachers to re-view the video once again in order to identify whether the students are making connections to the image of the matchstick patterns in Figure 1, or connections to the numeric sequences in Figure 2 or are solely reporting the calculation they did. This includes considering the differences between (a) Sonia saying 12×4+1 and 4×12+1, (b) the formula 4n+1, (c) the first term plus multiple common difference formulation 5 +11×4, and (d) Sam's 21 + 7×4. This leads to another possibility to support Sam in explaining his thinking by offering "*sufficient variation in the examples to actually highlight what he's saying*". Thus offering another example, for instance another term later in the sequence to identify or the twelfth term of the linear sequence 5, 11, 17, 23, 29 … to allow him to articulate his thinking on a similar problem, rather than just pausing.

The challenge these teachers are facing is that "*you're not just trying to teach them how to find the `nth' term rule of a linear sequence, you're trying to teach them how to explain how they find it, which is a whole different thing and means they've got to know what is a good explanation and what isn't, which goes back to what do we accept as a good explanation? So, are we accepting, because 4 x 12 + 1 is 49? Is that an explanation of wh*y?". In order to improve students mathematical explanations we need to consider what counts as a mathematical explanation as well as to consider the discursive moves to support students in articulating their explanations. We offer the example of the case of Sam's explanation and the CoNCAV approach as a contribution to the development of this aspect of mathematical work of teaching.

Conclusion

In this paper we examined the efforts of one teacher working to improve her students' communication skills. Following discussion and multiple re-viewings of the video clip in the meeting, what counts as good communication is critiqued by the teachers. Different future teacher actions were suggested which related to the different interpretations of Sam's explanation, in contrast to Sonia's. Anna focused initially on whether Sam's explanation was correct and the issue being the clarity of his explanation. She then suggested giving Sam more time to articulate his explanation until it became clear. Laura focused solely on the clarity of Sam's explanation and suggesting using Sonia's explanation as a model of clarity whilst also raising the issue of whether this would be sufficient to enable Sam to give a clear explanation for himself. Finally, Dave considered the mathematical content of the two explanations given and suggested the inclusion of an extension to the task being worked on or a similar task to enable Sam to explain across more than one example.

The CoNCAV approach thus enabled the teachers to view the students' explanations from different perspectives in a collaborative setting, whilst focusing on the key issue of working on students' ability to communicate their thinking. This led to an emphasis on the two-way nature of communication, the need for joint sense making between teacher and students, and consequently privileging explanations that communicate mathematical understanding both in terms of clarity and in terms of their mathematical content. The meeting also resulted in the identification of a range of potential actions for responding to students' explanations that are not clear, or where it is difficult to make sense of the student's explanation, in the future.

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