The role of pauses in developing student explanations in mathematics lessons: Charlie's journey

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In this paper we report on part of a two-year collaborative project seeking to develop the explanations students give during mathematics lessons. One cycle of the project explored teachers' use of pauses during whole class teaching. A key contribution of this exploration is the exemplification of choices about pausing along three dimensions of possible variation: when within the context of the lesson to pause, where within a sequence of interaction to pause, and why to pause in terms of intended learning outcomes. We focus particularly on the experience of one teacher as he introduced using pauses during whole class teaching. This identifies issues associated with implementing changes in practice, which orientate around social and emotional implications of pausing, and additional planning demands placed on the teacher.

Keywords: pauses; explanations; teaching choices; collaborative research

Introduction

Opportunities for talk in the mathematics classroom are taken to play an important role in broadening a student's mathematical vocabulary, bringing increased lucidity to their explanations, and more generally developing and communicating their mathematical understanding (Rogoff, 1991; Sidney, Hattikudur & Alibali, 2015). Research into promoting student talk in classrooms has considered the teachers' role in providing verbal prompts that can develop students' explanations (e.g. Franke, Webb, Chan, Ing, Freund & Battey, 2009). As well as what teachers say, consideration has also been given to the role of pauses during whole class teaching. The role of 'wait time' has been highlighted (for example by Black, Harrison, Lee, Marshall & Wiliam, 2003) and it has been asserted that greater learning gains have followed from students being afforded more time to formulate a response to the questions that teachers pose (Mercer & Dawes, 2008). The current paper builds on an analysis by Ingram and Elliott (2016) of the role of pauses in classroom interactions, considering choices available to the teacher concerning when within the context of the lesson to pause, where within a sequence of interaction to pause, and the intended outcomes of pausing. We also look to explore the wider implications of a teacher introducing the use of pauses into their whole class teaching.

Talk in mathematics classrooms that occurs during formal whole class teaching can follow a predictable turn-taking structure (McHoul, 1978; Ingram & Elliott, 2014). The initial turn of a sequence of interaction may well be taken by the teacher, perhaps in the form of a question. The teacher may nominate a student to respond to the question, or continue with their turn. Given that a student is nominated, there will be a point in time at which a further change of speaker could be appropriate. The turn might either return to the teacher, who could nominate a further student, or the teacher might decline the opportunity to speak, allowing the student to continue their turn. . This structure can be broken by students self-selecting – or speaking 'out of turn' – and this is a reality of even the most formal whole class teaching. However,

for the current purposes of modelling talk in classrooms this scenario will not be considered.

The turn-taking structure of talk in mathematics classrooms during formal whole class teaching affords extended pauses between turns, and these pauses can be exploited by the teacher so as to enact particular educational aims (Ingram & Elliott, 2016). Taken as teacher actions, extended pauses can be inserted in each of the sequences of interaction described in the previous paragraph. These possibilities are summarised in table 1, where they are also coded for teacher turn (T), student turn (S) and pause (P). The four possibilities are associated with the categories of wait time identified by Ingram & Elliott (2016).

Table 1. Structure of turn-taking in formal whole class teaching, including pauses.

Sequence of turns	Code
Teacher initiates, teacher pauses, teacher continues	TPT
Teacher initiates, teacher pauses, student responds	TPS
Teacher initiates, student responds, teacher pauses, teacher replies	TSPT
Teacher initiates, student responds, teacher pauses, student continues	TSPS

The extended pause within the TPS sequence is associated with affording students greater time in order formulate a response to the teacher's question. Ingram & Elliott (2016) report on studies that suggest that pausing for more than three seconds is associated with an increase in the likelihood of response and ultimately greater learning gains. Rowe (1986) reports that teachers who initially sought to extend the length of a pause within a TPS sequence also over time adapted the nature of the questions they asked.

The extended pause within the TSPS sequence on the other hand is associated with opportunities for students to develop their response, leading to more lucid explanations. The pause is taken by the student as a sign of trouble, and as an invitation either to extend their already relevant response or to prompt a revision or repair (Ingram & Elliott, 2016).

There are therefore positive reasons why teachers may choose to pause during whole class teaching. Decisions to pause can be discerned along three dimensions: when within the context of the lesson to pause, where within a sequence of interaction to pause, and why to pause in terms of intended outcomes. However, there are other factors that may constrain available choices. The issue of self-selecting has been mentioned previously, and when not established as a classroom norm extended pauses can be taken erroneously by a student as an indication of trouble to be repaired through self-selection. Self-selection can undermine the teacher's attempts to exploit pauses in order to develop more lucid responses. This highlights that in addition to when, where and why to pause, a further consideration for the teacher is the social and emotional implications of pausing on their students.

Methods

In this paper we report on a cycle of a research project that focused on teachers' use of pauses during whole class teaching. This cycle is part of a two-year collaborative project between teachers and researchers that is seeking to identify actions that enable and support students in developing their explanations. The project involves two local

secondary school mathematics departments, who meet with us separately six times a year. The format of these meetings is a video club (van Es & Sherin, 2008), where in each meeting one teacher shares a video clip of a short episode from a lesson, which is then discussed by the group. Teachers also report on the systematic reflection they have carried out between meetings.

The data for the current paper is the transcript of one lesson episode that was presented at one meeting as well as the complete transcripts of the two meetings in which the focus was pausing during whole class teaching. We focused particularly on Charlie, who was the teacher that provided the video clip. The transcripts of the meetings were coded for instances of Charlie making reference to when, where and why he was pausing during whole class teaching, and the social and emotional implications of pausing on him and his students. Instances of references to these four dimensions by other teachers at the meeting were also coded. Given the collaborative nature of this project, teachers are voiced by the use of direct quotations from these meetings.

During the meeting in which Charlie shared his video clip, we invited him to code sequences of interaction as in table 1, using a supply of cards on which either the letter T, S or P was printed. Although we report on this, the purpose of this task was more to draw the attention of Charlie and the other teachers present to where he was pausing during a sequence of interaction than as a data collection activity.

Findings

Charlie initially chose to focus on pausing as an invitation to students to continue their turn, so the sequence of interaction coded TSPS in table 1. So as to exemplify this, Charlie shared a video clip from a lesson in which a Year 7 student was listing the factors of 32. The transcript of this lesson episode is given in table 2.

Table 2. Transcript of Charlie's video clip

Speaker	Talk
Charlie	One times (1.3)
Student	One times (3.9) thirty-two (5.1)
Charlie	What did you do next (0.7)
Student	Umm (1.1) I did two (1.7) times (7.1) two times (2.5) sixteen (.)
Charlie	Yep (4.2)
Student	And then four times eight

Note. The values given in parentheses represent the length of a pause to the nearest tenth of a second. The symbol '(.)' denotes a pause of less than 0.3 seconds.

Emotional implications of pausing

Within this clip, Charlie drew the meeting's attention to the sequence of interaction that was initiated by his question, "What did you do next?" and the student's extended response to this. He was invited to code this sequence using the T, P and S cards (see figure 1). Note that Charlie coded the 0.7 second pause after his question, the student's hesitation ("Umm") and the 1.1 second pause that followed as a single pause. He also coded the student utterances "I did two" and "times" along with the 1.7 second pause in between them as a single turn.

Figure 1. Charlie's coding of the sequence of interaction

Having coded the sequence of interaction in this way, Charlie drew particular attention to the pause that he had coded with a double P. He commented that this was a 'deathly pause' and continued:

> I was happy leaving that pause, although it was an uncomfortable pause, I pretty much knew there was going to be an end point.

The pauses following this were much shorter, with Charlie recalling that he was 'so relieved to get to the end' that he 'just cut [the student] off and moved on'. Another teacher, who was developing pausing having posed an initial question (coded TPS in table 1) and as an invitation for a student to continue their turn (coded TSPS in table 1), also made reference to their early experiences of using pauses as 'just so painful' and them feeling 'excruciatingly embarrassed'. However, this teacher reported that subsequent experiences were more positive.

Where pauses occur in a sequence of interaction

Charlie focused on the emotional implications of pausing when presenting his video clip, but we were also interested in the way that he persevered with offering this student the opportunity to continue their response, rather than selecting another student. Our analysis of the transcript revealed frequent pausing during the episode. The pause after the student utters "Thirty-two" was an invitation for the student to continue, however after 5.1 seconds Charlie took the next turn by asking, "What did you do next?" All of Charlie's utterances in this episode can be considered as prompts to move the interaction forward. Therefore the pauses in the three occurrences of the TPS sequence of interaction were different in nature to 'wait time' between teacher question and first student response. The teacher question that the student was responding to in the extract in table 2 was not even part of this brief episode. Therefore all pauses in this extract can be considered as invitations for the student to continue to talk. Charlie's utterances can also be considered as continuation invitations, but this raises a question that we have not had the opportunity to pursue of whether the action of these utterances is any different to pausing. In short, are these teacher utterances redundant? Charlie was certainly conscious of the temptation as the teacher to self-select to speak rather than pause, and spoke of trying not to interject 'when I didn't think I needed to'.

As researchers we were interested in where Charlie paused during sequences of interaction, but he reported that he attended to other features when teaching:

> I was more conscious of allowing the kids more time to speak and to articulate whatever they wanted to say, rather than where I placed the pauses.

Although we were attending to different features, there is alignment between our interpretation of all pauses in the extract affording the student opportunities to continue to talk and Charlie's intention of allowing students opportunities to articulate. This offers further support for the validity of pause analysis in researching the development of quantity of student talk in classrooms.

Social implications of pausing

Despite the frequency of pauses in this episode and the considerable length of some, there were no instances of other students self-selecting to speak. This was a feature of Charlie's initial experiences of pausing as an invitation for a student to continue to talk. But he reported that how in a short time this changed, and students in this Year 7 class more frequently became what he described as 'jumpy'. This jumpiness included students becoming distracted or either raising their hand or self-selecting to speak. Charlie commented:

> I just can't keep them still or quiet for long enough to pause.

Other teachers in the group reported how students were able to adapt over time to changes from previous classrooms norms. Charlie recognised this, but questioned whether pausing as an invitation for a student to continue to talk could be used as an occasional strategy:

> You either have to do it every lesson or not at all.

Planning implications of pausing

Another change that became significant as Charlie used pauses during his whole class teaching was to the nature of questions he posed. He noticed how he was beginning to 'phrase questions differently'. Teacher questions that make pausing relevant are those where something other than a short student response is appropriate. Such questions do not always come to mind in the moment when teaching. Time was a constraint here for Charlie. "If I had time," Charlie said, he could plan questions that would make pausing relevant. Subject knowledge was a factor, and he reported that such questions were easier to plan for when he was more comfortable with the mathematical content. However, the implication was that time pressure meant that planning questions for every lesson was not feasible, and that without planned questions pausing might be less relevant in every lesson. Combined with his 'every lesson or not at all' statement, Charlie seemed to be expressing doubts about whether such changes to his teaching were sustainable. Nevertheless, he stated that he was determined to persevere.

Implications for learning

Charlie spontaneously made one reference in the meetings to student learning. He spoke of how for one student allowing time 'helped him with the language' as the student was given space to formulate a response. We chose not to explore learning outcomes further with the teachers in the meetings, since instead in due course we will conduct an analysis of transcripts of video recordings of lessons that the teachers have provided.

Conclusion

In this paper we have reported on the journey of Charlie, who wanted to offer students greater opportunity to articulate a fuller response to his questions and who tried to use pauses as an invitation to students to continue their turn. As well as offering examples from mathematics lessons of where within a sequence of interaction teachers paused, we considered when pausing was relevant. Charlie's experience exemplified how relevance is linked to the nature of the teacher's question, but that it is also relevant when allowing time brings a fuller response to articulation. Previous studies that have

explored the use of pauses have claimed a positive effect on learning, but as yet we have little to report on this aspect.

Finally we offered examples from natural classroom settings of the social and emotional implications of teachers introducing pausing during whole class teaching. Initially teachers reported that pausing felt uncomfortable. Using pauses also represented a deviation from previous norms of classroom interaction and called for revised ground rules to be agreed. However, these implications were seen as transitional and that new norms could be established where pausing was more natural. A more ongoing concern was the time taken to plan questions that made pausing relevant. This was not resolved in the current cycle, but a future cycle may explore teacher questioning.

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