Observe, interact and act: teachers' initiation of mini-plenaries to scaffold small-group collaboration

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Mini-plenaries, the shift in discussion from group to class and then back to group during the course of a small-group collaborative activity, have long been part of the repertoire of teachers. Despite this, they are not considered in detail in the research into teacher orchestration or classroom interaction. This article explores the behaviours of two teachers prior to their decision to initiate a mini-plenary. It considers the impact of technology and classroom conditions on this decision. It also looks at the impact of mini-plenaries on student learning and discusses what the initiation of a mini-plenary may signify within the current theoretical framing of classroom orchestration and teacher–student interaction.

Keywords: orchestration; scaffolding; collaboration; scripting; ICLC; mini-plenary

Introduction

Orchestration and its limitations

Collaborative learning, the process of two or more students working together to find a joint solution to a task, is associated with robust gains in student learning; developing both the versatility and the depth of understanding of students (Barron, 2000, 2003). The importance of the teacher's role in collaborative learning settings has long been recognised and continues to gain in importance as a focus for study (Cohen, 1994; Gillies & Boyle, 2008; Kaendler, Wiedmann, Rummel, & Spada, 2014).

The teacher's role in the initiation and support of collaborative learning has been conceptualised as 'orchestration' (Dillenbourg & Jermann, 2010). Orchestration refers to the actions of the teacher to influence learning, within the limitations imposed by the physical, social and political context in which they work. Such limitations may include: length of the school day, length of the lesson, content of the syllabus, the size/complexion/organisation of the class and the available resources (Dillenbourg, 2013).

This metaphor has been interpreted in two ways. Researchers focused on designing tools and learning environments have seen the teacher as an orchestrator of a musical score, adapting it to the needs of a given ensemble (Dillenbourg & Jermann, 2010; Dimitriadis, Prieto, & Asensio-Pérez, 2013). Those researchers looking at teacher behaviour have seen the teacher's orchestration as part of a virtuoso performance: the teacher must conduct, improvise or choreograph the affordances,

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constraints and people present in the classroom to achieve the optimal learning experience for each individual (Kollar & Fischer, 2013; Sawyer, 2004).

The main contribution of the metaphor has been to focus the attention of the research community on the actual processes required of the teacher who is asked to create and sustain a collaborative learning activity, particularly in a technology-enhanced environment (Beauchamp, Kennewell, Tanner, & Jones, 2010; Nussbaum & Diaz, 2013). Nevertheless, it has its limits. Orchestration, stripped of its metaphorical significance, remains a focus for thought about teacher activity in two respects: the pedagogical orchestration of a classroom and the design for improved orchestration of technologies that enable teachers to develop the learning activity in an optimal way (Dillenbourg, 2013).

Orchestration, dialogic interaction and power

Researchers focused on the design implications of teacher orchestration have been criticised for ignoring the realities of the teacher in the classroom. Specifically they have overlooked the implicit and inescapable power imbalances which pervade a teacher's interactions with their students (Perrotta & Evans, 2013).

Teachers are encouraged to orchestrate teaching and learning situations in which a dialogic form of interaction occurs. Dialogic interaction describes the process by which students assign meaning to new experiences as they continually recreate their model of the world. Either between the teacher and students, or amongst students, this is a form of interaction which is temporally and contextually situated, reciprocal, supportive, cumulative and purposeful (Alexander, 2001; Wegerif, 2006).

Normatively, orchestration is a process of developing students' understanding by recognising and clarifying their existing model of the world and then drawing upon this to enhance it and facilitate the articulation of a joint understanding among the participants in a dialogic interaction (Kennewell, Beauchamp, Jones, & Tanner, 2008; Littleton, 2010). The teacher's role in orchestrating learning is a process of managing the affordances and constraints of the available tools as they perceive them. This perception is mediated and developed through activity (Dohn, 2009). The goal of orchestration is manipulation of these affordances and constraints in the most optimal way to support student learning. The teacher constantly has to recalibrate the equilibrium between scaffolding and fading required to enable groups or individuals to complete a set task (Beauchamp & Kennewell, 2013).

However, the persistence of perceived power relations despite teacher efforts to engineer dialogic interactions between themselves and their students is one of the major contradictions inherent within the task of orchestration. Through skilful blending of affordances and constraints presented by the tools and ideas available to them within the classroom, teachers may work to establish a genuine dialogue with their students, one which is as far as possible free from the inhibition of unequal power relations. Yet such a dialogue will be transitory at best, ultimately overwhelmed by the constraints inherent within the greater school ecosystem such as expected norms of behaviour or the exigencies of the timetable.

Teacher interaction during an activity

The responsibility for the orchestration of a collaborative learning activity may be placed on the teacher. However, the delivery of high-quality collaborative learning is

an extremely difficult task. Its success depends on the richness and intensity of inter-actions of group members. If group members are able to: (i) give and be receptive to each other's explanations, (ii) agree shared meanings through negotiation and (iii) argue using a shared framework of internalised rules, then there is a very high prob-ability of favourable learning outcomes (Dillenbourg & Hong, 2008; Dillenbourg & Tchounikine, 2007).

Unfortunately, developing the culture and competencies within a class of stu-dents necessary for a teacher to establish and sustain collaborative learning is neither a quick nor an easy process. Teachers sometimes lack confidence to implement col-laborative learning (Gillies & Boyle, 2008). Learning experiences which result in such rich interactive experiences require careful planning as well as split-second reflection and reaction by teachers. The Implementation of Collaborative Learning in the Classroom (ICLC) framework is an attempt to describe and locate the many required competencies a teacher must master if they are to achieve consistently high-quality collaborative learning experiences for their students (Kaendler et al., 2014). The framework builds on the work of Artzt and Armour-Thomas (1999) which divides teacher activity into three phases: (i) the pre-active phase, (ii) the inter-active phase and (iii) the post-active phase.

Pre-active phase

The teacher plans the activity by first identifying the learning goals, then the charac-teristics present in the classroom (available tangible and intangible resources). Based on their analysis of these, they then select the appropriate macro-script which they believe will structure the collaboration to maximise the likelihood of beneficial stu-dent interaction. Macro-scripts structure a collaborative learning activity. They differ from micro-scripts in that they are a broad overview into which all activity should fit, they are fixed before the lesson commences and they are not intended to be inter-nalised by the students. Micro-scripts are brief processes which form part of the modes of interaction used by students and teachers during the collaborative learning activity. They may be as brief as a conversational turn in a single exchange with a student. It is possible for macro-scripts to unfold over multiple teaching sessions (Dillenbourg & Tchounikine, 2007).

Macro- and micro- scripts are organisational ways of thinking which, whilst very different in granularity from each other, are nonetheless part of a continuum. Other researchers have contrasted various scripts in different ways, distinguishing social scripts (which structure how students collaborate) from epistemic scripts (which structure the learning content) (Weinberger, Ertl, Fischer, & Mandl, 2005). Scripts have also been categorised as internal or external from the point of view of the lear-ner. The internal script is one within the learner which relates to how they act in col-laborative learning situations. External scripts are those given to the learner by the teacher. When planning, teachers must give careful thought not only to the prior learning of the students but also to the likely internal scripts which they bring with them. There is a danger that discord between the detail of a prescribed external script delivered by the teacher and the existing internal scripts in the students will lead to problems of over-scripting which will inhibit learning by stifling inquiry, or under-scripting which will give insufficient structure to student interaction (Kollar & Fischer, 2013).

Inter-active phase

During this phase, the teacher wishing to promote and sustain collaborative learning monitors activities, specifically the interactions between students. Monitoring activity is a prerequisite for supporting students. Based on observations, the teacher decides if, when and how they should intervene in group activity. Such intervention, in a computer-supported collaborative learning context, is micro-scripting – a split-second intervention which responds to the perceived needs of students. This usually takes the form of a verbal utterance or longer exchange; however, it can be a non-verbal cue or response to student activity (Dillenbourg & Crivelli, 2009).

Xun and Land (2004) identified three kinds of prompts teachers employ to support collaboration: procedural, elaboration and reflection prompts. They argue that the more experienced the learners become, the less procedural prompts they will need, charting a shift towards reflective prompts which foster metacognitive processes.

Teachers must make a decision whether or not to support or give feedback as soon as a need is identified. Immediate support prevents students from becoming unmotivated and supports task completion. Delayed support at the end of an exercise can stimulate metacognition and, by encouraging students to identify their own mistakes, enhance self-regulation skills (Deiglmayr & Spada, 2010).

The final stage of the interactivity is the consolidation of student learning by the teacher, which frequently takes the form of a plenary or whole-class discussion which focuses on the learning outcomes achieved by the group (Lampert, 1990). During this discussion students are made aware of any differences between their solution and the canonical solution presented by the teacher. They should also be encouraged to focus on the underlying concepts, relevant features and a principle of the task whilst the teacher enhances their metacognitive processes by discussing these differences (Kaendler et al., 2014).

Post-active phase

The post-active phase is one of reflection-on-action where teachers should compare their initial goals to their actual behaviour and that of the students. This stage enables teachers, in reviewing the work of individuals, to detect problems which persist. It also allows them to identify critical incidents which influenced the experience of the lesson for the teacher and the students (Kaendler et al., 2014).

The mini-plenary

This study focuses on the agency of the teacher as an orchestrator of a collaborative learning activity during the inter-active phase of the ICLC framework. Research has focused on teacher/small-group interaction (Gillies & Boyle, 2008; Greiffenhagen, 2012) and on the role of the teacher in leading whole-class discussion in order to bring a learning activity to a close with a plenary (Lampert, 1990). The intermediate stage of teacher intervention during small-group working has not been studied in depth.

Webb (2013, p. 39) suggested teachers can obtain powerful results by inviting students to reflect in whole-class discussions upon their interactions at a group level. Kollar and Fischer (2013, p. 509) discussed the positive learning gains which can be achieved when 'plenary and dyadic learning phases' are alternated by teachers. Nevertheless, this idea of teacher-led transition between registers of dialogue is one

which is not explored in detail. It is this gap in the research literature which this study attempts to supply.

The mini-plenary, a common form of teacher interaction in the English primary system, is an instance where the teacher interrupts group-level collaborative learning activity to address the whole class or to attempt to engage the whole class in discussion, before allowing them to resume their small-group collaborative activity. This form of interaction is therefore neither an interaction with an individual or a group to whom the teacher has decided to give immediate feedback, nor is it a full plenary which brings closure to the lesson and stimulates metacognitive reflection on a completed activity. The mini-plenary is not addressed in the literature but nevertheless forms a staple part of a teacher's repertoire of micro-scripts for intervention.

The mini-plenary and emerging technology

Mini-plenaries are part of a teacher's repertoire which they can initiate at any time. However, the development of new 'cockpit' technologies, designed to support teacher orchestration of lessons, means the process of initiating one can be much easier and less time-consuming (Dillenbourg & Jermann, 2010; Kaendler et al., 2014). This study does not present mini-plenaries as a new innovation per se. However, studying them in the context of the SynergyNet project has been important for two reasons. Firstly, the SynergyNet lab-classroom was equipped with a suite of teacher tools which enabled the instantaneous locking and unlocking of all student multi-touch tables; this had the effect of redirecting all attention to the teacher immediately. Secondly, the SynergyView tool, developed for the project, allowed for the combination of multiple streams of audio-video and transcript data. This allowed for analysis at multiple levels of granularity, from individual to whole class. Such flexibility in representing the data to the researcher has been identified as having the potential to greatly enhance understanding of group processes nested within a classroom setting (Mercer, 2008).

The SynergyNet project

The SynergyNet project examined the developments in pedagogy needed to utilise the capabilities of a fully integrated technology-enhanced learning environment based around the use of multi-touch tables and interactive whiteboards (Higgins, Mercier, Burd, & Hatch, 2011). By focusing on the role of the teacher, this article complements the other work done in the project exploring student-centric issues: the complexity of student reasoning in collaborative activity (Higgins, Mercier, Burd, & Joyce-Gibbons, 2012), adaptive expertise in collaborative mathematics challenges (Mercier & Higgins, 2013), the effect of room orientation on group performance during collaborative tasks (Mercier, Higgins, & Joyce-Gibbons, 2014) and emergent leadership behaviours among students working in groups (Mercier, Higgins, & da Costa, 2014).

Research questions

The SynergyNet study was based around the classroom interactions of two teachers, each working with students to complete collaborative mathematics tasks under different classroom conditions. Unprompted, both teachers were observed initiating

mini-plenaries at various points during the sessions they taught. Given that this is the case, this study will investigate the following:

- Is there evidence that mini-plenaries are related to the conditions under which the various sessions in the SynergyNet study were run?
- Are there interactional reasons why teachers initiate mini-plenaries and are these the same for both teachers?
- Does the fact that the small-group collaborative activities are taking place in a technology-enhanced learning context show and/or facilitate explicit detailed analysis mini-plenaries as part of a teacher's repertoire?
- What relationship exists between the mini-plenary and the learning taking place in the small-group collaborative learning tasks?

Methods

Data collection

Data collected in this study came from audiovisual data of groups of students completing mathematics tasks in the SynergyNet lab classroom. Data were recorded on ten video cameras and six microphones. These cameras, allowing the researchers to view the activity of all students from multiple angles, were situated in the ceiling of the lab. The unobtrusive nature of the cameras for the learners and the variety of views available to researchers obviated many of the issues of subject awareness and camera sensitivity which have challenged past research relying on video data collection (Barron & Engle, 2007; Plowman & Stephen, 2008; Smith & Hardman, 2003; Smith & Higgins, 2006).

Studying mini-plenaries in the context of the SynergyNet project made an overlooked yet well-known part of the teacher's repertoire visible by enabling teachers to more easily initiate them. It also allowed researchers to study the facets of mini-plenaries in greater detail than was possible with older data collection tools and techniques.

Participants

There were 96 participants (aged between 10 and 11 years); 48 boys and 48 girls participated. Participants were seated in groups of four students in four groups: red, green, blue and yellow. Participants were anonymised with a unique letter-number reference. None of the participants were registered as having a special educational need of any description.

Schools

Participants were drawn from six schools. These ranged in size and socio-economic circumstances. The six schools have been anonymised for this study and are referred to as: Benbrook, Dunhume, Easterburn, Seacrest, Shadbrook and Yadstone.

Gender-grouping and room conditions

Four schools had participants seated in mixed groups (2 boys, 2 girls). Two schools had participants seated in single-gender groups.

The organisation of the room was varied throughout the study. In first three sessions the schools were seated with the tables facing inwards (centred room orientation). In the final three the groups were all facing forwards (traditional room orientation).

Tasks

Each session consisted of three numeracy problems. All participants were given the same tasks in the same order. Task 1 (reasoning) required groups to demonstrate numerical reasoning. Task 2 (arithmetic) required them to use a sequence of arithmetical calculations. Task 3 (logic) required them to use logical reasoning to structure a chain of events.

The tasks were closed (they each had a single correct answer) and designed to be completed by a group. The tasks each 'forced' collaboration by requiring the analysis of large numbers of clues to solve the task, the number of clues being too great for a single individual working alone to master, thus provoking cognitive over-load and requiring two or more group members to work together to find a solution.

Teachers

Leading the lessons (in the teacher's role) were two researchers. Both were qualified teachers with extensive experience in Year 6. Both were male. They are referred to as Michael and David. They both taught groups which were both mixed and single-sex and in centred and traditional orientations.

Data transcription

Multiple streams of data were synchronised with the transcripts of student and teacher talk for simultaneous analysis using the SynergyView tool. Transcription was undertaken by several members of the SynergyNet team and all transcripts were checked by two members of the team who were familiar with the local dialect in which the students frequently spoke.

Analysis of task success

The extent to which each group was successful in completing each task was coded from 0–3 (0 was a group which did not engage with the task at all; 3 was a group which successfully reasoned to the correct answer). Inter-coder reliability on a 10% sample of this coding was 86% agreement.

Observational data analysis

To explore possible reasons why teachers initiated mini-plenaries, careful observa-tion was carried out of the teacher's behaviour during the minute preceding the start of a mini-plenary. The researchers paid particular attention to the movements and interactions of the teacher during this time.

Ethical procedures

All participants in the research were informed of the methods to be used in the study before their visit. Researchers visited them in their schools and presented the

purpose and methods of the project before eliciting written consent from the participants and their parents. On arrival in the lab, the students were shown the audiovisual data capture procedures and invited to ask questions. No data were collected without the students' prior knowledge.

Results

Mini-plenaries in the different conditions of the study

An exploration was carried out to explore whether there were any statistically significant associations between the duration of mini-plenaries and the conditions under which they occurred. If any such statistical association was present, it may suggest that other factors, rather than teacher agency, were prompting the instigation of the mini-plenaries. However, no test showed the presence of a statistically significant association (with a value $p = < .05$) between any condition and the duration of mini-plenaries (see Table 1).

Teacher initiation of mini-plenaries

The minute prior to the initiation of each of the nine mini-plenaries and the first minute (or part thereof) of each plenary were examined to determine whether there were any behaviours of the teachers which may indicate why they chose that particular moment to initiate a mini-plenary. The results show that each teacher followed a consistent yet distinct pattern of behaviour prior to initiating a mini-plenary.

Michael: Seacrest

Michael initiated four mini-plenaries. On all four occasions he did so immediately following an interaction with one group of students. During the course of each

Table 1. Number of mini-plenaries, mean duration and probability of statistical association wth study conditions.

Condition		Number of mini-plenaries	Mean duration	Result
School	Benbrook	2	63.5	$X^2(28, n = 9) = 32.250$,
	Dunhulme	1	76.0	$p = .264$
	Easterburn	0	0	
	Seacrest	2	64.0	
	Shadbrook	3	51.0	
	Yadstone	1	42.0	
Task	Reasoning	1	29.0	$X^2(14, n = 9) = 18.000$,
	Arithmetic	5	73.0	$p = .207$
	Logic	3	44.3	
Room orientation	Centred	6	53.8	$X^2(7, n = 9) = 6.750$,
	Traditional	3	68.0	$p = .455$
Gender	Mixed	5	54.4	$X^2(7, n = 9) = 6.075$,
	Single-gender	4	63.7	$p = .431$
Teacher	Michael	4	61.5	$X^2(7, n = 9) = 6.975$,
	David	5	56.2	$p = .431$

interaction, he found that the group was working under a particular misconception which, unless corrected, would prevent them from completing the task. The mini-plenary was initiated to then make the whole class aware of the misconception.

When interacting with Seacrest (green group) during the logic task, Michael discovers that the group are working with two misconceptions. The task required the groups to work through a number of logical steps to discover what one of the characters, Mike, should have to eat. Firstly, they think that the character mentioned in the question is intolerant of all dairy products just because he is allergic to yogurt. Secondly, they believe they have found the right answer to the task but for incorrect reasons, having ignored many essential pieces of information. Michael then talks to the group, discussing their ideas with them. Once he has worked through the misconception with them, he then stops the whole class to highlight the potential difficulty to them.

g56	Pizza, he should have, make that big, make them small, la da da... This is what we think he should have.
Michael	Yes. Why do you think he should have that?
g56	Because if he... if he...
g55	Because he doesn't like the em yogurt.
Michael	He can't have the yoghurt
g56	If he doesn't like yogurt, doesn't like dairy, so he can't have the cheeseburger...
Michael	uhumm
g55	And he can't have that yogurt that Tanya was having.
Michael	No, I wouldn't worry too much about the dairy – but I think you're on the right lines but what you've got to do is try and work out who gets what. So, Mike gets the yoghurt and he can't eat it. Who gets the yoghurt?
g54	Mike.
g53	Tanya.
g55	Tanya.
g56	Tanya.
Michael	All right – Tanya has salad – I wouldn't do that because you won't be able to get it back up. Tanya has salad, so who gets the salad?
g55	The em the vege-...
g56	Jack!
g55	It's Grace, it's Grace! It's Grace!
g56	Grace.
Michael	Why?
g56	Grace gets the salad because she's a veggie.
g55	Because she says that she doesn't like anything with meat...
Michael	She's a vegetarian – right so she has chicken wings there so who gets the chicken wings?
g54	Tanya's got the salad. Tanya's got the salad.
g55	Who picks it?
g56	Anybody want these chicken wings, asked Grace. I don't like anything with meat in it.
g53	Ruby, Ruby gets the chicken wings.
Michael	[Addresses whole class] Right. Can I just stop you a second? We're nearly there. So, I just want to – because a few people have said: 'Mr [Michael], I've got it, I've got it!' and they may or may not have the right answer, but they haven't thought about all the possibilities. You've got to explain to me who gets what for all of them, so Mike starts with yoghurt and he doesn't like yoghurt, so who gets the yoghurt

The green group claimed to have finished well before any of the other groups. However, the teacher interacted with them to lead them through more of the reasoning steps necessary to arrive at the answer securely. Once they were more secure in their understanding of the procedure of reasoning through the tasks and were prepared to work through the outstanding clues, Michael instigated the mini-plenary. A very similar sequence of events was followed when Michael instigated mini-plenaries with Yadstone during the arithmetic task.

Michael: Dunhulme

During the arithmetic tasks, Michael engages with the Dunhulme red group. This group had two strong personalities (r79 and r80). Each was separately convinced they had the correct answer. Neither student engaged with the teacher's questions as he tried to initiate a further reflection on the clues. Rather than further engage the group in what may have deteriorated into a confrontational situation, Michael chose to shift the register of interaction to a whole-class level. Michael chose to avoid a similar confrontation at group level with the Seacrest red group in the arithmetic task.

r78	Yeah, we've got it
r78	Sir, we've got it
Michael	Do you think you've got it because there's some clues there you haven't read.
r77	We haven't
r79	Yeah we have actually, I've got it
r79	Oh, I've lost it now, I was thinking of it.
r80	Eight times two hundred and fifty
r79	Yeah
r80	Thanks
r80	Two thousand
r79	That's four thousand
Michael	Why do you need eight times two hundred and fifty
r79	We've got it, it's two thousand.
r80	Well we've got this ten rides every hour, there's eight hours each day so that's eighty
r79	Then it's two pound each time so two times two thousand is four thousand pound.
Michael	Right, okay, so let's…
r79	Four thousand pound.
Michael	Can I stop you there please, right what do we know so far? We know there… Tell me an important fact. There are…?

In the four mini-plenaries initiated by Michael, there were two patterns of behaviour. First: taking the reasoning of one group as a proxy for the reasoning of the whole class, one group made an erroneous decision, therefore the whole class is at risk of a similar error. Second: a mini-plenary can be initiated to correct the erroneous reasoning of a single group without provoking confrontation between the teacher and the stronger personalities in the group. This has two didactic purposes. The group in question are confronted with their mistake in a way which is non-confrontational and the rest of the class are alerted to the possible issue to be avoided.

David: Shadbrook

All five mini-plenaries instigated by David follow a consistent pattern. Each occurs after a period of observation. During this period David's behaviour was consistent with him assessing the progress of all the groups relative to each other. He then identifies the group which has progressed furthest towards the solution.

The interaction within the mini-plenary is focused on taking the class through a number of the steps necessary to ensure that all groups have reached an approximately uniform stage in their reasoning consonant with the leading group identified by David.

David uses the mini-plenary to model best practice; eliciting key pieces of information (and the reasoning associated with them) which form steps in the critical path towards task completion. In the Shadbrook arithmetic task, David spent time observing the class, predominantly the red group, before initiating the mini-plenary.

David	Right, I'm going to stop you there just for a sec and make sure everyone knows what it is they've got to do. So can you just look this way a sec? What's the problem? What's the question about? What do you need to know?
g38	Are we trying to work out how much it costs to keep the waltzer running?
David	Not quite but you're on the right lines.
y34	Is it how much the waltzer o, the waltzer makes, how much money it makes?
David	No
r45	It's how much money he needs to give every 10th person a cuddly toy.
David	Yes, exactly. The waltzer owner wants to get more people to go on his waltzer so he's going to give away a free cuddly monkey for every tenth person that goes on the ride. And you've got to work out how much it's going to cost him to pay for a monkey for every tenth person who goes on the ride. So you're going to need to know how many people go on the waltzer in a day. What are your first thoughts?

Discussion

Mini-plenaries and the conditions of the study

Mini-plenaries were not planned into the macro-script of the sessions in this study but arose naturally, unplanned. Their duration varied greatly, from a few seconds to over a minute (see Table 1). They are not associated in a statistically significant manner with any of the conditions of the study. This would imply that their initiation was wholly due to a decision by the teacher based on their monitoring activities in the inter-active phase of the ICLC cycle.

Teacher differences in initiation of mini-plenaries

Whilst there are some essential characteristics which define a mini-plenary, the two teachers in the study both initiated and conducted them in different ways and for apparently different reasons. David was consistent in his silent observation of the class before initiating a mini-plenary. He focused the discussion on task completion, leading a discussion whose apparent aim was bringing all students to a coherent stage in their reasoning.

Michael consistently initiated mini-plenaries immediately after interaction with students. His apparent aims were both procedural and task-completion focused. Mini-plenaries were used on the one hand to make the whole class aware of a potential issue which could inhibit their ability to find the correct solution to the task. On

the other hand they had a procedural aim specifically for the group with whom he had been interacting prior to initiating the mini-plenary. They modelled a best practice in procedural reasoning which was intended to contrast with the group's previous non-collaborative behaviour or erroneous reasoning.

Common features of mini-plenaries

Mini-plenaries are not explicitly addressed in the ICLC model put forward by Kaendler et al. (2014). They may be best regarded as a response to under-scripting in the pre-active phase of the ICLC. Mini-plenaries can be described as improvised macro-script which occurs following monitoring of group collaboration and requires whole-class interaction. Yet their focus is not on consolidation in the manner of a plenary at the end of an activity, rather on supporting activity aimed at task completion.

The teacher identifies the need for a structured sequence for the whole class and initiates this. Their questions and responses to the students' replies are guided with reference to a pre-existing archetype which they have selected during the monitoring phase. This archetype guides the structured (didactic) interaction. The mini-plenary is a more dynamic script than 'alternation' of plenary and group activity proposed by Kollar and Fischer (2013).

Common features of a mini-plenary include:

- teacher decision to intervene during rather than at the end of an activity;
- an improvised macro-script;
- teacher directly stops all groups;
- teacher initiates didactic dialogue;
- teacher returns students to their group-level work on the task.

Mini-plenaries as scaffolding activities

Focused on the completion of the task, the mini-plenary is an improvised form of scaffolding delivered to the whole class. In both cases observed in this study, the teacher models the reasoning processes they wish to see the groups acquire and use. In the mini-plenary the teachers treat the students as if they already have this proficiency and engage with them as if this is the case (Wertsch, 1979). Having interacted already with or observed a group prior to initiating the mini-plenary, the teacher can be certain that some students will already have this proficiency. During the mini-plenary the teacher takes and changes student responses to better align with the path to the solution of the task (O'Connor & Michaels, 1993). By initiating mini-plenaries the teacher is scaffolding by modelling the articulation and reflection needed to progress towards the solution of the problem (Quintana and colleagues, 2004).

The learning which occurs through the scaffolding of thinking cannot be expected to happen immediately. It is a gradual one as over time the learner imitates the modelled actions and associates them with the processes necessary to succeed in the task. This process, referred to as *prolepsis*, is one of the explanations of how learning occurs through such scaffolding processes (Reiser & Tabak, 2014; Wertsch & Stone, 1985).

The initiation of mini-plenaries has been shown to rely on the monitoring activities of the teacher. They are only one actor in the classroom and their viewpoint is limited. The evolution of the concept of teacher orchestration outlined by Dillenbourg (2013) has highlighted the limitations of the agency and awareness of teachers in their struggle to define the optimum conditions for learning in a classroom. It is possible that the initiation of mini-plenaries may not be the right choice for all students. In 9 out of the 18 cases, no mini-plenary was initiated at all. One school, Easterburn (taught by David), had no mini-plenaries in any of their activities. It is unavoidable that different learning needs, different zones of proximal development, will exist in any classroom. For some students the mini-plenary may have a cognitive benefit, allowing development in their reasoning processes. For others it may have procedural benefit, allowing them to disengage and refocus. For others the benefit may be vicarious, as others students re-engage and are able to provide secondary scaffolding which reflects development in their own reasoning (Reiser & Tabak, 2014). For other students or groups of students it may be an unwelcome interruption to otherwise successful working practices. For others, it may just be irrelevant as they were too procedurally disorganised to benefit from the concepts and processes the teacher is trying to scaffold for them.

Mini-plenaries, affordances and constraints

The initiation of mini-plenaries by both teachers, despite their different reasons for doing so, highlights the centrality of the issue of power within the orchestration process discussed by Perrotta and Evans (2013). The initiation of a mini-plenary is inherently disruptive to dialogic, open group discussion. During their monitoring and interaction with the groups, the teacher implicitly discriminates between reasoning processes and progress made by the groups.

The teacher must orchestrate the affordances and constraints present in the classroom to achieve the optimum learning outcome (Beauchamp & Kennewell, 2013; Kennewell et al., 2008).

The concepts of affordance and constraint are here used in a Merleau-Pontian context as embodied and interactional (Dohn, 2009). The process of orchestration requires the teacher manage affordances and constraints which are nested at various levels: group, class and school. The free inquiry afforded by group-level collaborative working activities is bounded for the students by the constraints of the conceptual and procedural understanding of the group members. The affordances and constraints perceived and experienced by the members of the group are different from those perceived and experienced by the teacher as they also experience different affordances and constraints acting upon them at a class level and school level. Learners may not give the structural, school-level, constraints of an activity the same weight as a teacher – such as the need to finish within a given time or to follow school procedural norms. One powerful constraint being time available, another being a requirement to have groups complete (to some extent) the tasks they have been set. The mini-plenary is an attempt by the teacher to resolve the tension caused by the competing affordances and constraints which act upon the teacher as they orchestrate group work.

David tries to resolve the need to enable free exploration of the problem, with the constraint that all the groups make reasonably uniform progress towards the completion of the task. When he is no longer able to tolerate the disparity he

perceives in the progress of different group, he initiates a mini-plenary. During his interaction with Seacrest in the logic task, Michael tries to balance the need to let students experiment with different reasoning approaches to solve the problem with the constraint that they eventually approach the correct answer within the time available. When he observes groups who are apparently unable to do this, he initiates a mini-plenary. In the case of Dunhulme, he also uses a mini-plenary to resolve the tension between letting students explore autonomously and the constraint of classroom hierarchy where his authority as a teacher has to be respected. In this case the mini-plenary models at a whole-class level, the behaviour he would expect at a group-level interaction.

SynergyNet, SynergyView and studying mini-plenaries

The ability to observe teacher and student behaviours in a specifically designed technology-enhanced learning environment has enabled the more detailed study of foundational pedagogic processes, in this case, the initiation of mini-plenaries (Nathan & Sawyer, 2014).

The mini-plenary is by no means limited to use in technology-rich classrooms. Teachers can initiate them at any time and with any class. The SynergyNet classroom enabled their use in a new design of learning environment, with teacher 'cockpit' technology which greatly facilitated the ease with which they could be initiated, reducing time spent in procedural transition (Higgins et al., 2012).

The versatility of the SynergyView tool and suite of audiovisual data capture technologies offered researchers the opportunity to gather more authentic and more detailed data than had been possible with large, free-standing eye-level cameras used in previous studies. Studying mini-plenary and other teacher–student interactions in the SynergyNet lab has provided an insight into the possibilities and challenges presented by multi-stream data collection. These challenges can now be addressed further in real classroom settings in subsequent research.

Limitations of the study

This study, conducted as part of the larger interdisciplinary SynergyNet project, was able to explore the interactions of two teachers with children drawn from six schools in groups of 16. The size of the classes, dictated by the cost, availability and space required for the multi-touch tables, did not fully reflect the authentic learning environment of the primary classroom. Likewise, although the two teachers who participated in the activity were both qualified and experienced, they were not the familiar teachers the students were used to. The SynergyNet lab classroom was as near an authentic teaching environment as one could make it. Nevertheless, it was still an unfamiliar room in a university context which was designed to meet the needs of numerous studies requiring the multi-touch tables. Thus students visiting the room were confronted by both an unfamiliar classroom and the presence of large multi-touch tables.

Owing to project financial and time constraints, the slightly uneven distribution of sessions between the teachers (David led two sessions with the tables arranged in the centred layout and one with them arranged in the traditional layout. Michael led two sessions with the tables arranged in the traditional layout and one with them arranged in the forwards layout) may potentially have affected the data collected.

However, given the consistency with which the study conditions were shown to have no statistically significant influence on the duration of mini-plenaries, it is unlikely that this was the case. The study was also only carried out during closed, mathematics tasks, which require a different kind of collaborative working practice and interactions to open-structure tasks which may be more pedagogically relevant in other subjects.

Conclusion

Mini-plenaries are acknowledged as a widely employed pedagogical technique, familiar in the craft of teaching yet not treated in detail within the existing body of pedagogical research relating to scaffolding, orchestration or student/teacher interaction. The primary purpose of this article has been to highlight their existence and some of the potential issues surrounding them to fellow researchers so that they are more aware of their character and significance when conducting future research into teacher/student interaction in a classroom environment.

The evidence of this study suggests that teacher decisions to initiate mini-plenaries are unrelated to the conditions under which the study was carried out. The decision as to whether or not a teacher should initiate a mini-plenary arises from their monitoring of student behaviours. This monitoring takes the form either of observation of the class or interaction with single groups, from which teachers then extrapolate judgements as to the progress and potential of the whole class with regard to the completion of the task. The SynergyNet classroom better enabled the study of mini-plenaries through the use of a teacher 'cockpit' which provided a more seamless transition from group work to class discussion. The SynergyView tool also facilitated the analysis of small groups working in a nested classroom environment as this provided a varied granularity of analysis to researchers (Mercer, 2008). Finally, mini-plenaries contribute to the learning of individuals as a form of scaffolding which teachers employ to address shortcomings in their pre-prepared macroscripts. Teachers support student reasoning by scaffolding the modelling and refinement of reasoning processes. As with other forms of scaffolding, the impact may not be immediate.

Further research is needed to develop a broader understanding of teacher behaviours and decision-making processes prior to the initiation of a mini-plenary. This will further inform an understanding of the phenomenological experiences of teachers as agents in the processes of classroom orchestration. Detailed observation of teacher behaviour prior to the initiation of mini-plenaries in authentic classroom situations is required to discover whether there are further common features or types of mini-plenary and whether any types can be aligned with existing typologies of scaffolding activity (Reiser & Tabak, 2014). Finally, detailed and prolonged investigations into the impact of mini-plenaries on group learning are required to explore the impact of mini-plenaries on the working practices of these groups over time. In this way, an understanding of the practical utility and the theoretical role of the mini-plenary can better inform the practice of serving teachers and teacher educators.

Note

The data which underpin this research are unavailable.

Disclosure statement

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Notes on contributor

Andrew Joyce-Gibbons is a lecturer in Durham University with research interests in technology-enhanced learning and collaborative learning, particularly in the classroom context. He is involved with primary phase initial teacher training. He was formerly an ESRC doctoral student on the SynergyNet project (http://tel.dur.ac.uk/synergynet/). Prior to this, he was a full-time primary school teacher since completing his Postgraduate Certificate in Education in 2004.

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