Article

Teacher Learning in Lesson Study: what interaction-level discourse analysis revealed about how teachers utilised imagination, tacit knowledge of teaching and freshly gathered evidence of pupils learning, to develop their practice knowledge and so enhance their pupils' learning.

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Abstract

This research examines what discourse interactions reveal about teacher learning in Lesson Study (LS) contexts as teachers plan and discuss research lessons.

LS group members combined social and cultural capital resources and vivid data from research lessons. This created motivating conditions enabling collective access to imagined practice and joint development of micro practices. Improvements in subsequent teaching, and pupils' learning are reported.

Iterative, collaborative LS processes enabled teachers to access tacit knowledge resources and remove filters (developed to cope with classroom complexity), unmasking hidden characteristics of pupils. This both challenged and informed teacher beliefs, motivating joint development of enhanced practices.

Keywords: Lesson Study; reflective practice; tacit knowledge; teacher learning; teacher discourse

Highlights

- LS focus on pupil learning (not teachers) fuels teacher disposition to learn
- LS group talk in role taps tacit knowledge reserves to improve micro-teaching
- Case pupils sharpen teacher understanding of proximal development needs
- LS helps teachers overcome classroom complexity and see pupils afresh

- Interaction-level discourse analysis of teacher talk makes teacher learning visible

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1. Introduction

The purpose of this research was to investigate how and what teachers learn in contexts of Lesson Study (LS). LS is a teacher learning process practised since the 1870s across Japan (Sato, 2008), the 1950s in China (Chen, 2011) and which since the 1990s has migrated across the Asia Pacific region (Lee, 2011), the US and Canada. It is now used in Europe, Africa and the Middle East (Dudley, 2012; Shimizu and Takuya, 2012).

LS has been reported extensively during the past 16 years in English language journals (Fernandez, 2002; Fernandez et al. 2003; Fernandez, 2004; Lewis, 1998; Lewis et al., 2004, 2006; Takahashi, 2005; Watanabe, 2002; Yoshida, 2002). It can be a formal demonstration-based practice transfer approach, but also exists as classroom action enquiry developing new practice knowledge (Chichibu and Kihara, 2013; Lo and Marton, 2012; Matoba, 2011; Tamura et al., 2011). This study focuses on the latter. This growing literature remains immature. While LS is associated with high performance (McKinsey, 2007; Mourshed et al., 2010; Stigler and Hiebert, 1999; Perry et al., under review) and is currently enjoying global growth, its precise impact, while promising, remains unproven.

The international context for my research lies in outcomes of a national pilot project in England (2003-5) conducted by the author, which drew on evidence principally from Japan and the US, exploring the use of LS in the UK (Dudley, 2004, 2011) and which prompted the research reported here. Elements of LS developed through this work are now informing international practice. These include two features reported here: 'case pupils', (Lee, 2011) and the use of teacher discourse as a window on teacher learning (Akita, 2012).

This research is the first to use interaction-level discourse analysis of teacher talk in LS to explore the patterns and modes of teacher learning that are revealed.

1.1 What is Lesson Study?

Lesson Study involves a group of teachers who want to improve aspects of the learning of their pupils, from underperforming groups to curriculum aspects that teachers feel could be taught more effectively. Having established this focus, the group researches what has worked elsewhere. (In Japan there is a wealth of teacher research arising from lesson studies upon which teachers draw). They then plan *in detail* a 'research lesson' (RL), which one of the group teaches while the others closely observe pupils' learning and annotate their copies of their RL plan. After the RL they compare what they have observed of pupils' learning with their predictions, refining their ideas and planning a further RL. After a cycle of three or so RLs the group clarifies what was learned that can inform their own practice and that of others. They share this with colleagues through short papers, presentations or by inviting them to observe the new approach in an 'open house' lesson.

Figure 1 below sets out the LS process followed in this study developed by trialling and adapting models from international literature during my earlier pilot.

INSERT FIG 1 HERE

Teachers in my LS pilot reported experiencing profound, new learning experiences – commenting particularly on: (i) the safe context LS provides for teachers to experiment with teaching while also being highly accountable to improving pupils' learning; (ii) the value and benefits teachers derived from learning collaboratively;

and (iii) on how LS processes enabled them to see their pupils in new ways based on detailed insights developed through focused classroom observation. These themes recurred constantly.

I was interested to find out why this might be and the study I report here examined how and what teachers learn in Lesson Study contexts and whether teaching practices were changed for the better through LS in meaningful and lasting ways that benefited pupil learning after their lesson studies were over.

2. Reviewed literature

In LS teachers seek to learn in collaborative groups from their classrooms. Classrooms have been found to provide powerful, practice-based contexts in which teachers learn to improve the ways they support enhanced pupil leaning (Cordingley, et al., 2004; Elmore, 2004; Guskey, 2002; Kazemi and Hubbard, 2008; Opfer and Pedder, 2011). In developing this research, I found sociocultural learning theory offered me a helpful lens with which to examine the collaborative, classroom-based teacher learning that is promoted through participating in LS procedures.

Learning is increasingly acknowledged to be both social and situated (Sfard, 1998). Sociocultural theory (Vygotsky, 1986) construes a learner as oriented to an object of learning, something which strongly motivates the learner, while learning is understood as a collaborative, social process in which new knowledge is socially constructed in shared contexts prior to any process of internalisation (Wells, 1999; Lave and Wenger, 1991; Kleine Staarman and Mercer, 2010). Socioculturalists have thus focused on the role of *talk* in the learning process - learning's tool of tools - deeming thought and language as inseparable, claiming that it is through social interaction, and especially social interaction *through talk,* that we are enabled to develop new knowledge. This reinforced my decision to study teachers' talk.

Cultural historical activity theory attributes importance to the knowledge-sets brought to any social group of learners through the participants' respective individual cultural historical experiences which help them to visualise the *object of their learning* (Edwards, 2004; Engestrom, 2011; Wood, 2013). For teachers engaged in LS the object of their learning is new knowledge about how to improve the learning of their

pupils in specific classroom contexts. I therefore determined to study not only the nature of the collaborative discourse of teachers engaged in LS, but also the knowledge and cultural histories they drew upon in doing so. Teacher talk in LS contexts promised to reveal something about teacher learning and about how teachers utilise and develop knowledge.

2.1 Teacher knowledge and teacher learning literature

These literatures provide insights into the challenges that the nature of teacher practice knowledge poses to those who wish to improve teaching. I firstly examine what the literature tells us about teacher professional knowledge and its influence on teachers' learning.

Teacher knowledge and learning are both distinctive. For example, teaching requires not only procedural and propositional knowledge of the content to be taught, but also Shulman's (1986) 'pedagogical content knowledge'; (PCK) which comprises: knowledge of how content relates to the subject and curriculum; knowledge of common errors or misconceptions that learners are prone to form as a result of a particular teaching approach; and also knowledge about the particular learners themselves (Ball et al., 2008; Hill, et al., 2008).

Teachers' knowledge of classroom practice is also distinctive.

The distinctive nature of 'teacher practice knowledge' (James et al., 2007) is shaped by the complex 'swiftly flowing river' (Lewis, 1998) of the classroom which blinds teachers to many instances of pupils' learning (Wragg et al., 1996; McIntyre, 2000; Arnot, et al., 2004; Gallimore and Stigler, 2003). Teachers have to make many more decisions than do other professionals and very quickly. They therefore have to find ways of coping with the deluge of information they receive as they teach. This is partially achieved by using 'reference pupils' as typical proxies for groups of similar learners in the class (Clark and Peterson, 1986). Such strategies involve filtering out classroom information not deemed immediately critical to the teaching that is happening at any given moment (just as humans unconsciously filter-out extraneous sights and sounds throughout the day). These characteristics mean that most pupil learning behaviour is likely to be missed by a lone teacher with a class of 30 (Nuthall

and Alton-Lee, 1993). Others however, have observed that LS processes can 'slow down' action in a classroom by bringing multiple perspectives to bear on this fast-moving complexity (Ermeling, 2005; Willis, 2002).

The coping mechanisms of early career teaching create problems for professional learning later on. Teachers cope with the overwhelming demands of making so many swift decisions by utilising *tacit knowledge systems* to subconsciously store thousands of micro-strategies developed as they learn to teach (Huberman, 1993; Eraut, 2000). These can be retrieved when next needed without the use of conscious thought (just as we draw upon our tacit knowledge of how to ride a bicycle only when we are actually on one). These strategies are not stored as conscious propositional knowledge because teachers need their 'working memories' for urgent classroom matters in hand. So tacit knowledge forms, which are generally invisible and not consciously accessible to teachers, are used to store non-urgent practice knowledge. Teachers are thus unaware of most of the knowledge they use to teach when in action in the classroom and find it difficult to elucidate, describe or change their practice as a result.

One factor which strongly influences teachers' practice knowledge is their knowledge of their pupils. This can be seen in the way that teachers' knowledge of specific practices that they observe changing their pupils' learning, influences their subsequent practice (Guskey, 2002; Webb and Vulliamy, 2006). [1]

2.2 Lone practice

The nature of teacher practice knowledge thus affects teacher professional learning models. Ideally, such models should help teachers to access and use their tacit knowledge stores. But there are also historical factors which affect teacher learning affectively and cognitively. Lone practice has become a default model in the West (Huberman, 1993) where seeking help from another can be seen as a sign of professional weakness (Hargreaves, 1993; Little, 1993). In England the presence of a

[1] Seeking feedback from pupils about their classroom learning experiences has helped develop teachers' understanding about the usefulness (or otherwise) of ways in which they attempt to support pupil learning. Regrettably there is not space here to report on the agency of pupils in the model of LS used in this study.

fellow professional in one's classroom is associated with performance management or inspection, which does not create the safe space needed to promote teacher learning.

Studies of effective teacher learning models and conditions (Cordingley et al., 2004; Pedder, 2006; Kazemi and Hubbard, 2008; Opfer and Pedder, 2010) suggest that teacher learning that strongly promotes improved pupil learning occurs when:

- Teacher learning takes place over weeks (not days);
- The classroom is the central location of professional learning activity;
- Experimental enquiry into pupil learning features in the teacher learning process;
- There is collaboration with one or more other professionals(s) in that process.

(Dudley, 2011).

As all four of these conditions exist in LS, I decided not only to study teacher talk in the professional learning process, but also to examine social conditions within the LS groups, that promote teacher learning, and the forms of knowledge they draw upon in this process.

2.3 Research questions

The literature and the outcomes of my pilot study led me to identify the following research questions in relation to how and what teachers learn in LS:

1. What kinds of things do LS group members learn? How does this new knowledge help them to improve their support for pupils' learning – and how is it realised and made available to others?
2. What forms of knowledge and motivations do LS group members draw upon and use in order to influence and inform this learning most successfully?
3. What do features of interaction and collaboration in the work of LS groups reveal about the nature of teacher learning and the generation of new practice knowledge amongst members?

3. Methodology

Because of the centrality of talk to teacher learning I analysed video recordings made by groups of teachers of themselves jointly planning and analysing RLs in order to throw light upon *how* and *what* they were learning. My pilot study had suggested that it was through these discussions that teachers revealed most evidence of:

a. Their knowledge of pupils, classes, content and pedagogy;
b. Opportunities created for 'risk-taking';
c. How they designed RLs to facilitate the learning of *specific* pupils;
d. How LS group members collaborated;
e. How they used observation evidence to analyse pupil learning;
f. How they developed this analysis into ideas for change and revised teaching approaches to improve pupil learning;
g. Pupils' agency in these processes;
h. How knowledge that their LS would later be made public affected LS group decisions and behaviours.

I hoped to capture detailed evidence of these through discourse analysis.

3.1 Note on three features of the Lesson Study model in use in the study

I will briefly describe two developments of my pilot study that became core elements of the LS model used in this research because they are important in relation to the findings.

Case pupils are chosen to represent or typify learner groups whom it is important to observe and understand in the RLs. If the LS focus is on disengaged pupils, then the case pupils may be pupils who fall into this category. If the research question is more general, for example, 'How can we teach ratio more effectively in our Year 4 module?' then case pupils may typify or represent pupils in higher, middle or lower attainment groupings in mathematics. Teachers plan the RL for the whole class but keep their case pupils in mind, specifying what they hope each will be doing at key points in the lesson. There are usually three or four case pupils. During a RL, teacher and observers focus on the whole class and the lesson as a whole, but also on the case pupils – especially at key points in the lesson when their anticipated or intended behaviours were specified in the plan. Case pupils are sometimes used in Japan (Kuno, 2010) and their use in this study has influenced work in Singapore and the UK (Lee, 2011; Maddern, 2012).

The ***post-lesson discussion convention*** (Dudley, 2011, 2012) was introduced to help the post-lesson discussion concentrate on what was observed and to steer initial discussions away from an immediate focus on teaching or the teacher. The convention requires the LS group members to discuss:

1. Firstly, their observations of the case pupils' learning compared with what they had predicted;
2. Secondly, the way other pupils had learned;
3. Thirdly, the effects of the teaching on the pupils' learning and what teachers might do differently in the next RL, or in future teaching.

It (i) created a discipline whereby participants used and referred to evidence gathered from their observations and (ii) prevented this session from feeling judgmental, thus allowing all the teachers equal access to any learning gained from the discussion.

3.2 Scope of the study

Two LS groups participated in two schools (CS1 and CS2) working with 9 year olds. CS1 served a deprived urban neighbourhood; CS2 was in middle-income suburbia. The two CS1 teachers focused on developing open questions to promote pair-talk in mathematics in order to increase pupil engagement, confidence, active mathematical thinking and thus attainment of unengaged pupils. The three teachers in CS2 developed use of self-assessment and oral rehearsal through role-play in order to improve engagement and attainment of unengaged boys in writing.

These two groups audiovisually recorded themselves planning and analysing their RLs, then planning their subsequent RLs. Two months later each teacher participated in a semi-structured interview reflecting on what had been learned during the LS and on any lasting changes in pupil learning and teaching that resulted. Headteachers were also interviewed to reflect on these processes.

Four hours of video material were transcribed and initially analysed in broadly inductive sweeps. A discourse analysis was then applied at the level of interaction in order to explore and re-explore the discussion. The interviews were also transcribed,

and a content analysis was carried out in the light of the discourse analysis of the discussions. These analyses generated the following outputs.

3.3 Development of case stories, codes and categories

A case 'story' was written for each LS, which acted as a second-order analytical database. These contained the narrative – plot, motivations, action and denouement of each of the two lesson studies: the way the groups formed, identified their foci and their case pupils; the ways they interacted to construct their RL plans and analyses. They also illustrated what they and their pupils learned as a result. The case stories drew on transcript data as well as on the teacher and head teacher interviews.

In addition, participant interactions in the discussions were initially coded in terms of both:

i. the function each interaction performed within the discussion. These were called *interaction function* (IF codes).
ii. the type of knowledge that the speaker was drawing upon whilst making the interaction. These were called *knowledge type* (KT) codes.

As I engaged in the process of coding, I became aware of patterns in the exchanges and interactions which resonated with Mercer's (1995) categories of talk types.

Mercer found that pupil groups engaged in collaborative work firstly establish themselves within the group in early 'brainstorm-like' exchanges during which one idea and then another idea is offered with no real reasoning or challenge (disputational talk). As the group gains clarity about purpose and roles, the talk becomes more attuned to relationship-building in which equally unchallenging 'yes and' interactions cement mutual respect, confidence and help 'form' the group (cumulative talk). A third stage is reached when the group becomes collectively absorbed in achieving their goal – encountering 'cognitive dissonance' in ideas they cannot resolve but thinking collectively - 'interthinking' (Mercer, 2001, p. 648) - in an intrapersonal zone where collective negotiation of meaning allows the group to harness collective cognition, to manipulate and adjust ideas and achieve together what would be unachievable for one member alone. Mercer terms this 'exploratory talk' which is linked with evidence of pupil learning.

> In exploratory talk knowledge is made more publicly accountable and reasoning is made more visible in the talk. Progress then emerges from eventual joint agreement reached.

(Mercer, 1995, p. 104)

Repeated sweeps through the transcripts revealed that Mercer's three categories of pupils' collaborative group talk – disputational, cumulative and exploratory - could also be used to understand *teachers'* talk in LS groups.

IF codes were assigned to the following talk types:

1. Cumulative talk
2. Qualifying or disputational talk
3. Exploratory talk
4. Structuring conversation
5. Managing understanding.

Table 1 lists the interaction function codes identified in the LS group talk in the five talk types identified, and also gives illustrations of them in use derived from the transcript.

INSERT TABLE 1 HERE

The fourth and fifth talk types were purely organisational or transactional and not significant to the findings reported here. Table 2 lists the five knowledge type codes representing the kinds of knowledge upon which teachers drew upon in their discussions.

INSERT TABLE 2 HERE

There are echoes of pedagogical content knowledge types developed by Hill, Ball and Schilling (2008) which should be further explored in any similar future analysis.

3.4 Learning points and episodes

Sixty interactions revealed a teacher expressing a change in attitude, belief or knowledge about teaching. These exchanges were coded as *learning points (LP)*. The four or five exchanges preceding each learning point were termed *learning episodes*.

3.5 Incidence analyses

One quantitative analysis examined the relationship between the incidence of learning episodes with talk types, interaction functions or knowledge types. A second established the distribution of IF codes amongst learning points.

3.6 Optimising data and validation

Seven teachers and education professionals matched IF codes to talk type categories with 89 percent accuracy. They were also provided with examples of coded transcripts and accounts of the learning that was evidenced by a learning point or string of learning points within the transcript extract, producing a 100 percent match.

Emerging and final findings were shared with participants in order to establish that the findings were authentic and credible, and sometimes to explore further questions with them.

4. Findings

While I address each research question here, the nature of my data also required me to explore interplay between what teachers drew upon (their knowledge and evidence) and how they used discussion to overcome problems this evidence often posed for them. 4.1 explores qualitatively *how* the teachers used knowledge and evidence as well as collaborative discourse to accommodate contradictory perceptions, explore these differences in understanding and then formulate new ideas. 4.2 describes the impact these new ideas (or knowledge) had on their beliefs, practice and their pupils' subsequent learning. 4.3 highlights some striking findings from the quantitative analysis related to how these features of interaction and knowledge were associated with learning points.

4.1 What the teachers found out and what ideas this gave them to support their pupils' future learning

Improvements in teaching and assessment quality, developed as a result of these teachers' participation in LS, were clearly evident in this study and demarcated by learning point evidence, as we shall see below. All teachers reported that they had gained significant new knowledge of (i) how to teach writing or mathematics and (ii) the prior understandings, capabilities and learning needs of their pupils. These reports were consistent with the evidence from the learning points. Important developments in teaching were reported to have been retained in subsequent classroom practices months after the lesson studies were completed.

Common features in the kinds of knowledge teachers developed were revealed through the learning points and also reported by the teachers across the two case studies (CS). Teachers gained important new knowledge about their pupils: how they learn and how their learning could be improved in the future – and this was particularly evident and clear with respect to the case pupils. In each CS at least one case pupil was discovered to be operating at a considerably higher level than the group members had previously thought. This led teachers in each CS significantly to raise their expectations for these pupils and to pitch subsequent teaching at a level more suited to their true needs, which, teachers reported, led them to make sustained subsequent progress.

The LS teachers developed other forms of PCK. Sometimes this replaced existing ideas and strongly held beliefs about teaching practices. Rose (CS1) believed that her pupils would benefit if given '*open questions*' to explore mathematical concepts, such as negative numbers and place value, using small-group discussion (which they were accustomed to using in their English lessons). Table 3 shows how this focus developed through the LS stages.

INSERT TABLE 3 HERE

Rose believed that her pupils' learning in mathematics was suppressed because they felt so stressed attempting *closed questions* requiring 'correct' answers, that they were

unable to explore or experiment with mathematical thought in the way that they did in discussions in English lessons where *open questions* were used to invite conjecture or opinion. Rose reported having been trained that truly 'open questions' are ultimately speculative and have no correct answer (for example, *'What might Harry have been thinking then?'*). She thus believed such questions could not be employed in *mathematics* lessons where there usually are correct answers.

Rose was steadfast in this belief. It was only through repeatedly encountering evidence to the contrary - while planning open questions and imagining possible pupil responses or through actual observations of pupils' learning in RLs - that Rose began firstly to question and later to 'let go' of this belief. She came instead to a new understanding – that it *is* possible to frame questions in mathematics that promote exploratory talk amongst pupils, allowing them to explore and manipulate mathematical concepts and, in so doing, to learn them through talk.

In the transcript below the pair begin to frame open questions but then falter, realising they are creating closed questions (135 and 137). Wanda tries to imagine what the children will be prompted to think when they hear the question, and in 137 she finds an approach, which she rehearses aloud, concluding that it does 'open' up the question. They formally adopt this in interaction 141. Wanda again employs the rehearsal approach as she problem-solves the next open question that they need to ask (144), this time explicitly reflecting on how they should 'try to get behind their (pupils') reasoning'. She is partly in coaching mode, asking, 'Is there something we need to do?' This prompts Wanda herself to rehearse two ways of asking the children a similar question (145). She forms a hypothesis (as a result of having listened to herself articulating both forms) about why one form is more likely to 'get behind' the children's reasoning. Although Wanda leads the discussion, Rose becomes engaged as an equal as a result of her participation in the rehearsal process in interaction 145, and it is Rose who closes the discussion by summarising their proposed action, (while also acknowledging their continued failure to develop what she thinks of as truly 'probing' open questions). It seems that they have used 'rehearsal', 'reflection', and 'hypothesis' (see the IF code column) to reach a position where they are both clear about how they envisage the detail of this sequence of their lesson and are comfortable that their adopted approach at least begins to 'open up' the questions,

even if it does not entirely meet Rose's strict criterion of 'having no correct answer'. (Learning point exchange numbers are in bold type.

Urban Primary Session 1 Interaction sequence 1.

Interaction no/time	Speaker	Interactions	IF code	KT code
0.28.00 134	R	I'm trying to think how we can move on to the questions because these are all closed!	Chal	PCK
135	W	Mm. Well, we can then say….. They can then show us any other shaded part and give us the fraction as well as the decimal.	Deve	PCK
136	R	So using another piece of paper we might ask them to shade four-tenths.	Reas	PCK
137	W	Or we could say to them. Cos four-tenths.. If we ask them to do four-tenths, that's going to be closed. If we say, 'Shade any other part and show us'. So that opens it up. So they now have to *decide* which part they are going to shade.	Reas	PCK
138	R	And show it in three different ways.	Add	PCK
139	W	Yeah. Record.	Echo	PCK
140	R	Record it.	Echo	PCK
141	W	I'll write that so we can put that in. And say as an open question..	Prop	PCK
142	R	Or could they just tell their partner? So it's safe. So it's not telling *everyone* yet? [i.e. the whole class]	Sugg	PupK
0.29.00 **143**	W	Yeh. We could say 'Tell your partner', and then ask if anybody wanted to share. Because everybody gets an opportunity to share by sharing with their partner.	Echo	PCK
0.30.51 144	W	(*Reading from the Year 4 mathematics planner*) What happens when we count past one? I mean this is where we... We can probably ask something like, 'Why do you say that?' or 'How do you know?' Try to get behind their reasoning for that. Um. Is there something we need to do before we ask that question?	Refl	PCK
145	R	Would you count 1.1, would you say 1.1, 1.2, 1.3, 1.4? And they say what happened after? Would you actually do the activity and then ask why or would you just get to one and say, 'Now what happens?' If you get to one and say 'Now what happens?' the children are learning. They'd have understood it better in a way.	Hyp	PCK
12 exchanges				
157	R	It's all really closed, isn't it? And you have to be closed because there is no.. it's just a right and wrong. It's… No *probing* is there.	Refl	PCK
158	W	Well, we can say – instead of saying, 'What is twenty-tenths the same as?' we can say, 'What do you know about twenty-tenths?'	Chal	PCK
159	R	Now that seems clever.	Supp	PCK

In interaction 138 Rose begins to 'get in step' with Wanda's thinking. She demonstrates this by adding to Wanda's idea, then finishing Wanda's sentence (140) and making a suggestion based upon their, by now, shared train of thought. This leads her to suggest (142) that the pupils will be less intimidated if they, firstly, make their responses in the safety of their pair - 'so it's not telling everyone yet'.

At moments like this we can hear her thinking aloud, explaining, almost for her own benefit, why such a talk opportunity for the pupils is perhaps more 'open' than she had imagined. In the next exchanges we see her waver between her original belief and the possibilities that now seem to be offered by the evidence she has *imagined*. She responds positively (159), revealing a readiness to adjust her conception of what might happen in the children's minds as a result of Wanda's new wording.

However, doubt creeps in moments later when she reverts to her former position forgetting how, seconds earlier, she had felt it important that a question 'sounds' more open, so promoting a less constrained feeling amongst her pupils and giving them room to talk.

166	R	Just the wording has made the question sound more open. But really there is only a closed answer anyway isn't there. Don't we want probing questions to be…

But nine exchanges later she shows clear signs of changing her position again. In 176 she echoes Wanda's words, listening to them with the ears perhaps of both teacher and pupil. In this brief moment she seems to access her tacit knowledge. She can clearly see and feel again that this form of words, while demanding only one answer, nevertheless *feels* less constraining to the pupils.

175	W	But it's just.. I mean it's….The difference is in the wording of the question. Because. Instead of saying, 'What number is next?' It's almost by saying, 'What will happen?'…..	Expl	PCK
176	R	(chiming in) 'What will happen!'. It opens it up a little, doesn't it?	Deve	PCK

While seemingly insignificant in themselves, small steps like this (176), building up over the course of the whole LS, combined together, eventually causing Rose's view of the nature of 'open' questions in mathematics to shift so significantly that she was able to accommodate her new knowledge in a completely revised conception.

Rose's (initially) reluctant conversion to this new knowledge position is visible across several series of learning episodes identified during planning and post-lesson discussions. An example of a shift in her belief can be seen in her observation (below) made following a RL in which she witnessed her own pupils using paired conversation to explore place value. She begins to accept that such learning is possible in mathematics:

22	Rose	'… what really came out of it very clearly was, if you're paired up correctly, it is really helpful. [Pupil A] was with [Pupil K]. You know. Still (Pupil K) is in the bottom group but a little bit more savvy than [A], and [K] was explaining and [K] was getting it slightly wrong. And as he was explaining it to [A], he realised he was going wrong. And he explained it again. So [K] not only got it clear in *his* head, because *he* was having to explain it to [A], [A] learned from [K] *too*. So you're right.

Generalising from these observations she later begins to construct a more formal theory about how children learn using open questions and peer talk in mathematics.

46	Wanda	….You know, but our lessons definitely showed that the paired work. You know the paired talk.....
47	Rose	….increases participation and confidence..
48	Wanda	Yeah. Yeah.
49	Rose	..and the child who really knows it, has to explain it to the child so they kind of *re-consolidate* what they know. And that child's getting the double whammy. They're getting it from the teacher *and* from their friend. So its win-win all round isn't it! But it does take up more time which is what.... But it's probably time well spent though!

This learning point marks the moment Rose begins actively to espouse her new knowledge about how questions in mathematical questions requiring 'correct' answers can be framed in ways that invite discussion.

Sometimes the LS added new levels of detail and depth to knowledge that teachers had previously held more superficially. Sometimes it revealed methods of classroom application they had not previously considered using. In CS2 experienced and less experienced teachers attempted to increase pupils' motivation and engagement by using drama techniques and role-play to orally-rehearse written diary entries (see Table 4). This improved motivation and engagement in writing for a number of previously disengaged pupils and also teachers' understandings of how these pupils

were learning and the levels at which they were operating (see 4.2). The way these foci developed through this LS is set out in Table 4.

INSERT TABLE 4

In the CS1 transcript, teachers were developing their untaught lesson, imagining how their pupils might respond to the way teachers ask questions and to each other as talk partners. By contrast, this CS2 conversation draws heavily on data the LS group members collected from the RLs. The transcript is taken from the post-research-lesson discussion. The LS group is reviewing what and how case pupil (C) learned in comparison with their predictions.

Interaction no/time	**Speaker**	**Interactions**	**IF code**	**KT code**
88	K	He started but then he gave up. The introduction for lesson one (reads his observation notes) 'Looking around. Doesn't read off board. Fiddles with pen'. So! 'Quiet', 'attentive', um.. 'Passive response to pictures'. He was quiet. He was … He was half-attentive. Erm. Responsive to pictures? No, he wasn't ...	Reco	ObsK
89	L	No?	Expr	
90	K	No, he really didn't take any of the sort of ..	Refl	ObsK
91	L	Stimulus?	Sugg	PK
92	K	Stimulus! And work at all with that. It, it's.. Those pictures and things would have really helped..	Refl	PK
93	L	Yeh.		
17m 94	K	You know, erm, the picture, the scheme. Um and then.. What's that mean?	Requ	PK
95	L	So the - yeh (reads from the group's predictions for C's learning) '[He is likely to succeed in][2]..rephrasing the criteria but do it without reasoning or the aim of the bigger picture' So I think we were saying 'he'd be able to read the success criteria but that he wouldn't really see …'	Expl	PupK
96	Y	(finishing L's sentence) .. 'give an example' or 'explain it'..	Add	PupK
97	K	I think the success criteria for him….	Refl	PupK
98	L	It was too academic.	Refl	PupK
99	K	Yah…….It…He didn't refer to it. He didn't think about it really in his writing..	Deve	ObsK
100	L	No.		
101	K	No, when he, he, he… when he got involved in the story.	Just	ObsK

[2] Insertions in squared brackets are author's to aid understanding

102	L	Yeh.		
103	K	But he wasn't thinking about the sentence structure.	Just	ObsK
104	L	No. (*Referring closely to the pupil's work which he had just picked up.)* And the sentences that he's picked out as 'best', don't relate to the success criteria really.	Obsv	ObsK
105	Y	(*Looking over Lloyd's shoulder at the work.*) He's underlined the whole lot … Oh no, he hasn't quite, really but he's underlined the majority. But its only basically one sentence he's written anyway.	Add	ObsK
106	L	Yeh.		
18 m 107	K	Um. (Reads again from predictions they had made) 'More active. Following [rather] than…'	Retu	PupK
108	L	… 'than leading..'	Add	PupK
109	K	Always following. Um. Yes he was……..I made a few notes..er……(reads notes) 'Not writing.. Not writing more than one line'	Just	ObsK
110	L	He didn't ask any questions for the characters?	Requ	PupK
111	K	No. No. .And I've got….yeh. (Reads) 'Listens but not really engaged in work'…um. He did write in the second lesson when you asked them to write ideas on the blackboard. He wrote 'scared' and he asked about 'nervous' and 'weather' .. So it shows he *had been* thinking.	Obsv	ObsK
112	L	Yeh.		
113	K	But, because of the fact that when we came to write our own diaries, he wasn't sure who he was writing [in role] as…..	Hyp	ObsK
114	L	…. It wasn't a lot of help to him.	Supp	ObsK
115	K	I don't think he was relating earlier stuff to what he was having to do….then.	Hyp	ObsK
116	L	No.		
19,00m **117**	K	So maybe when you're doing an exercise like that, it's a case of being more explicit for some [pupils]. Of saying, 'Right…'	Hyp	Obsk
118	L	'Who are you…?' [i.e. Who are you in role as?]	Sugg	Obsk
119	K	… 'We're doing this because later on in the lesson you're going to be…'	Rehe	Obsk
120	L	Yeh!		
121	K	..writing as a .. As a		
122	Y	What you're (indistinct but joining in and sounds like sentence finishing)		
123	K	…while they're doing that anyway….er…help..them..	Sugg	PK

Despite the abundance of data they possess, we can see in the transcript that they are, nevertheless, also using their imaginations to try to understand why Pupil C had responded and learned so differently from the way that they had predicted he would do when they were planning the RL. Keith and Lloyd build up a shared picture of what might have been going on in the pupil's thoughts, by piecing together fragments

of this picture of his thinking that were provided by their evidence (90 – 103). They reflect on his words and actions, raising potential explanations for them and looking for evidence in their data to support or refute these hypotheses. Lloyd (Pupil C's daily class teacher) was very surprised that Pupil C had behaved as he did. Keith's observation (103) suggests that he had indeed been following the lesson and thinking about the task but *not at all* in the way they had expected. Between interactions 113 and 119 these teachers' talk became highly exploratory as they developed a joint hypothesis about why Pupil C had misunderstood the task. They realised that he had not understood that he was not only expected to develop the ideas for his writing in role orally (which he had done), but that he was also expected *to write them in a diary while remaining in role*. Keith and Lloyd can be seen thinking in step with each other as they successively complete each other's sentences. Lloyd turns Keith's more generalised hypothesis about how pupils might need to be taught in similar circumstances in future (117) into the beginnings of a rehearsed enactment of it (118), which Keith completes through further rehearsal (119). In this interaction sequence they make extensive use of reflection, suggestion, justification, hypothesis and rehearsal in order to develop their explanation.

During these three final interactions the teachers came to a new understanding about how and why this pupil had responded to the task as he did, and they developed an agreed approach to make sure that pupils like C do not misunderstand things in this way again. This was evidence of these teachers learning something new for the future - interactions 117, 118 and 119 were thus coded as learning points. Yasmin had closely followed this sustained interaction sequence and interjects to add her thoughts at 122. The group seemed to have developed ways of enhancing their pupils' writing abilities as a consequence of improving their own *knowledge of content and students* (Hill, Ball and Schilling, 2008. p 377).

4.2 Changes to practice and pupil learning

Teachers in both schools later reported that they had changed the ways they summatively and formatively assessed pupils and formulated questions. For example Lloyd made significant changes to legitimise error-making at the drafting stages of

writing and Rose significantly changed the way she used talk and questions in her mathematics teaching. I will enlarge upon this.

Common themes emerged in the types and patterns of talk used by the teachers. In both schools, the deliberative process of LS seemed to break down self-consciousness between teachers through a protocol that values LS members equally as learners. This was strengthened by their shared goal of improving their pupils' learning and accelerated by group members' collective immersion in the production and analysis of RLs aimed at helping pupils to learn. In this way LS processes built common cause and consequently social capital amongst the group, engendering challenge and developing sufficient resilience to resolve disagreements and misunderstandings.

4.3 Rehearsal

Alongside this rapid development of resilience and social capital was engagement in 'exploratory' talk, which seemed vital to the accomplishment of these processes. While reflecting and hypothesising were key elements in both discussions, the groups also extensively simulated elements of teaching through their use of 'rehearsal' to test out and reflect upon different hypotheses. There are sequences of discussion in which many of these features combined and which paved the way for members of the group to shift their views of a pupil's learning or of their teaching practices. Some of these small learning points accumulated through the LS resulting in considerable shifts in the ways that LS group members conceptualised and thought about pupils and practice thereafter. Many informed subsequent teaching.

Teachers also discovered how use of technical 'shorthand' to describe teaching approaches, such as 'guided' or 'shared' work (terms used regularly in everyday planning conversations in England), masked considerable differences in classroom enactment of these approaches. The accountability that these LS groups were forced to demonstrate in RLs towards detailed classroom actions and speech acts, revealed that while they had thought they were conforming to teaching models, what they had actually been enacting in separate classrooms differed dramatically.

The most significant developments in both CSs occurred in two cross-curricular aspects of practice. The first was development in strategies for making intended learning outcomes *explicit* to pupils, (using devices such as teacher questions, success criteria, self- or peer-assessment), that were specifically tailored to the subject matter and which seemed to strengthen the pedagogical content knowledge of the teachers themselves. The second was development of 'practice-knowledge' (James et al., 2007) observed and reported by teachers, that better enabled them to engage their pupils in paired or group discussions which in turn helped pupils to undertake tasks or solve problems in ways that involved discursive conceptualisation or application and explanation of what it was that they were intended to learn.

In each case, teachers reported how they were later able to apply and to use new practice or pedagogical content knowledge in subsequent teaching, long after the LS was over.

There was evidence that their pupils gained immediate benefits from this improved learning in the RLs. Interview accounts of the LS group members in both case studies revealed that their pupils' learning had continued to benefit in subsequent teaching, as teachers became more confident in applying new practice knowledge or in supporting the pupils as a result of improved understanding of their needs. Both LSs revealed that certain pupils had been significantly 'under-assessed' for periods of time, suggesting that regular use of LS could increase such pupils' attainment simply by identifying them and more appropriately challenging them thereafter. At the levels reported in this study (and replicated in my pilot study) this could account for between 3 and 10 percent of all pupils.

4.3 Relationships between incidences of talk types, knowledge types and learning points and episodes

Exploratory talk was around 10 percent more evident in learning episodes than it was overall, which was not statistically significant. However Figure 2 shows the incidence of IF codes at learning points.

INSERT FIG 2 HERE

Figure 2 suggests while that teachers' learning was most visible in LS discussions when the LS group members were hypothesising, learning was also observed as they developed points, made suggestions, summarised or concluded or accepted someone's argument. However, what is perhaps most interesting here is the high incidence of visible teacher learning at points of 'rehearsal'.

This might indicate, as I have suggested in relation to the transcript evidence above, that the opportunities for LS groups to rehearse aloud and in role micro-exchanges planned for the lesson, help them to consider the effect of the exchanges *as if they were happening in class*. They can thus unconsciously draw upon and utilise their tacit knowledge of the pupils and classrooms in their response and even share tacit knowledge amongst group members. Given the limitations that tacit knowledge places on development of practice knowledge, this was perhaps this study's most important finding.

4.4 Knowledge types

Teachers drew upon knowledge of pupils and knowledge of pedagogy at learning points in both studies, but the most common association by far was with PCK. This supports my qualitative finding that the accountability to which LS group members are held by the level of detail required in their planning and analysis discussions, forces even tiny differences of view about practice or content to become exposed. The group needs then to resolve the cognitive dissonances (see p. 10 above) thus created between group members in order to address collectively the needs of the pupils in the imagined or re-imagined lesson, and these represent points of teacher learning.

5. Discussion

Teacher learning is the primary subject both of this study and its most important finding. Pupil learning is reported as an outcome of teacher learning. I will therefore confine this final discussion to teacher learning alone.

The features of interaction and collaboration in the work of these LS groups reveal how important is the building and use of social capital tools and resources amongst group members for creating conditions for teacher learning and also how the powerful ontogenetic *will to improve* pupils' learning adds momentum to this. The social function of the groups seemed to become one of a 'learning community' as members used exploratory talk to develop discussions through which joint endeavour overcame barriers to learning presented by the self-conscious egos of individual members. These processes are illustrated in Figure 3 below.

INSERT FIG 3 HERE

Mercer (1995) proposes that exploratory talk creates the conditions in which the minds of collaborators increasingly interlock to form an Intermental Development Zone in which interthinking can take place. Wells (1999) has developed ideas of ancillary and constitutive modes of exploratory talk as a means of moving cognition from group to individual, while Salomon (1993) proposes distributed cognition as a mechanism for achieving this. In this study the deliberative nature of LS, with its protocols and reflexive, reflective processes of imagining, observing, analysing and re-imagining pupil learning, seem to combine to orchestrate such collaborative learning processes both socially and culturally.

The forms of knowledge and motivations that LS group members drew upon and used in order to influence and inform this learning were: new knowledge of their pupils' learning encountered in RLs, combined with finely grained and shared understandings of aspects of curriculum or pedagogy – particularly pedagogical knowledge (such as that related to formative assessment practices and collaborative learning approaches) and PCK. In relation to this, case pupils played an important role in sharpening the focus of the groups on the learning of specific pupils who typify learner groups.

Figure 4 illustrates how these forms of knowledge were reflected back to teachers through LS processes, helping them subsequently to tailor learning opportunities, motivation and feedback to pupils.

INSERT FIG 4 HERE

The kinds of things LS group members learn and the ways in which this new knowledge helps them to improve their support for pupils' learning are described in Section 2 above. I will now reflect how this new knowledge is realised and made available to others.

Firstly, it was clear from comparing time that elapsed between RLs and post-lesson discussions that the sooner a post-lesson discussion happens after a RL, the more rewarding and effective it is. Caught moments, snatched snippets of dialogue – not all of which can be recorded – are critical if an analysis is to be sufficiently accountable to the level of detail that generated finely grained cognitive dissonance, group resolution and consequent learning points. Such detail is rapidly lost.

Secondly, emerging practice knowledge proved fragile as it developed in these LS contexts. Learning point data suggest that it sometimes developed at the expense of strong prior beliefs about practice, with numerous reversions to prior belief before new practice knowledge was eventually adopted. Transcripts suggest that LS groups raised their game, always conscious that they would make their LS outcomes public to colleagues. Interview evidence from this study however, suggests that new practice knowledge can decay after the LS, but that the process of passing on the new knowledge to others can help to 'fix' or cement the new knowledge by enabling teachers to reflect upon and publically advocate their newly learned practices.

LS then acts as a locus for co-construction of new knowledge between the LS group members and the imagining, observing, analysing and re-imagining of practice, and the effects of that practice help to distribute that cognition amongst the individual members.

5.1 Removing the blinkers

One final reflection on the nature of teacher learning and teacher knowledge in LS leads me back to the way these teachers dealt with the 'swiftly flowing river' (Lewis, 1998) of classroom learning. Participants in this study and in my pilot study frequently described being made more aware of the complex needs of each pupil.

Observing one case pupil had raised teachers' awareness of that pupil's learning and needs. These teachers then reported becoming aware of similar needs in several other pupils in the class. However, they did not report feeling overwhelmed by this: they reported it as seeing with new eyes.

It may be then that through LS, teachers learn to switch off 'filters' constructed early in their careers to cope with the speed and complexity of classrooms and which have subsequently blinkered their ability to see important aspects of the learning of many of their pupils. This is probably the second most important finding of this study because it suggests that LS can help teachers to comprehend their pupils learning in deeper, more complex ways and that this can be a revelation to them rather than a hindrance.

5.2 Wider issues this study raises about teacher learning models and current policy in the UK and globally

The frustrations and wasted effort experienced by teachers who have spent much of their careers pursuing ultimately unsuccessful, or even damaging, professional learning models are summed up well by Rose.

> [LS] is valuable because it develops the teacher. It develops your techniques. Definitely. And you don't normally have that luxury of taking a lesson and pulling it to pieces and analysing every little word and things. You normally just ..You just get going, don't you, and so. And once you've done that a few times, [*i.e. just got going without having analysed the effect of the approach on pupil learning,*] for a few lessons, you learn those [*ineffective*] techniques.

Evidence cited in Section 1 sets out the common features of professional learning models that make a difference to teachers' classroom practice. However, this study of teacher learning in the context of LS suggests further factors that are important to teacher learning. Warford (2011) postulates a Zone of Proximal Teacher Development (ZPTD) and how it could be optimised in designing teacher professional learning. In ZPTDs the object of pupil learning will change from lesson to lesson, but the object of teacher learning is always the same: it is the improved learning of pupils (see Fig. 5 below).

INSERT FIG 5 HERE

6. Conclusion

This study has trained a spotlight onto teacher learning co-constructed by groups of teachers through a process that generates co-constructed teacher knowledge and enables it to be distributed to, and fixed in, the practice knowledge and theoretical knowledge of individuals. From time to time the discourse analysis revealed evidence of this learning through learning point interactions which enabled several routes to be traced through periods of doubt about new ideas, denial or back-pedalling, set against other moments of illumination, revelation and gradual conversion to new belief about practice. It has shown how LS's deliberate, collaborative processes allow teachers to summon up and utilise otherwise invisible tacit knowledge and to switch off filters which, since their early careers, have blocked out important elements of daily classroom information. This has improved their abilities to see and assess their pupils' needs and motivations. The powerful motivation for the teachers involved was to learn how to improve the *learning* of their pupils. The use of case pupils in this LS process was instrumental in enabling this to happen. I have synthesised the findings from this small study into seven claims that could be tested by further research.

INSERT TABLE 5 HERE

The implications of this for continuing teacher learning, school-to-school support models and for initial teacher training are considerable. One challenge posed here is for school and system leaders. Five years of LS development in the UK at a national level (Dudley, 2012) generated compelling pupil outcomes across hundreds of schools (Dudley, 2008; Hadfield et al., 2011). Now randomised control trial findings from a US study suggest that LS significantly enhanced teacher knowledge developed when using high-quality curriculum materials and that the resulting teaching significantly enhanced student learning outcomes above those groups where a LS element was not included (Perry and Lewis, under review).

But many school leaders are put off using LS by the disruption they perceive will be created to the school timetable, staff cover system and supply teacher budget – not to mention the headache of convincing reluctant staff and governors that LS is rewarding and effective. This must be set against Robinson et al.'s (2009) meta analysis which found that the single most effective intervention that a school leader can make to improve standards of attainment is to become directly involved in school-based, improvement-focused and enquiry-led professional learning. A focus for subsequent research must therefore be how school routines, cultures and communities can accommodate these forms of teacher learning.

The methodological implication of this study is that interaction-level discourse analysis has helped to refract patterns of teacher learning from their complex and swiftly flowing discussions. While interaction analyses of coaching sessions (Lofthouse et al., 2010) and higher-level discourse analysis of teacher discourse in LS (Suzuki, 2012) have helped to show the potential for teacher talk to provide a window on teacher learning, neither highlights the degree to which teacher talk in LS contexts gives teachers access to their tacit knowledge stores, and holds them to account so closely for the detailed levels of classroom interaction, practice and knowledge that so significantly affect their abilities to improve their pupils' learning. Further research is needed to enhance the way discourse analysis can be used to improve understanding of teacher learning and to create tools to help researchers and teachers themselves consciously to use talk to better effect in their professional learning and practice-knowledge development.

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