

2015

Changing Teachers' Practices Through Exploratory Talk in Mathematics: A Discursive Pedagogical Perspective

Carol Murphy

University of Waikato, carolmm@waikato.ac.nz

Recommended Citation

Murphy, C. (2015). Changing Teachers' Practices Through Exploratory Talk in Mathematics: A Discursive Pedagogical Perspective. *Australian Journal of Teacher Education*, 40(5).

Retrieved from <http://ro.ecu.edu.au/ajte/vol40/iss5/4>

This Journal Article is posted at Research Online.

<http://ro.ecu.edu.au/ajte/vol40/iss5/4>

Changing Teachers' Practices through Exploratory Talk in Mathematics: A Discursive Pedagogical Perspective

Carol Murphy
University of Waikato

Abstract: This paper presents data collected as part of an intervention research project to develop exploratory talk and collaborative group work with six and seven year-old students in mathematics. A discursive approach was used to analyse and interpret variations in the way that three case-study teachers, involved in the project, managed the group work and developed the students' talk. Analysis suggested that the intervention required, not just a change in practice, also but a shift in ideologies for these teachers. Ideologies are seen as discourses that legitimate and maintain a social pattern, and the paper explores how a research-based intervention can create conflicts between researchers' and teachers' ideologies.

Introduction

Policy moves to encourage communication and interaction in mathematics classrooms have been in place for well over a decade in many countries. The introduction of the National Numeracy Strategy (NNS) (DfEE, 1999) in England at the end of the last century intended to change, not just what was taught, but also how to teach (Earl et al., 2003), and whole-class interactive teaching was seen as an intrinsic part of the strategy. Whole-class interactive teaching emphasised a teacher-directed approach (Smith, Hardman, Wall, & Mroz, 2004), that resulted in the teacher managing the classroom talk (Pratt, 2006). Later policy moves, and the introduction of the renewed Primary National Strategy (DfES, 2006), shifted the didactic emphasis to group teaching, where the teacher addressed the needs of students by guiding the learning in a group. The idea of high-quality talk was promoted within the group work, where students would have opportunities to contribute actively, and to share ideas with their peers (DCSF, 2010; Williams, 2008). However, the guided nature of the group interaction meant that the teacher still managed student talk in the group.

Research in mathematics education has also focused on communication and interaction in the mathematics classroom over, at least, the last two decades (Barwell, 2005; Cobb & Bauersfeld, 1995; Pimm, 1987; Sfard, 2001). Several studies have focused on the use of exploratory talk in mathematics (Hunter, 2007; Mercer & Sams, 2006; Sawyer, 2006). First termed by Barnes (1976), exploratory talk describes talk that is used to sort out ideas, and has been further defined by Mercer (2000) as talk where students engage critically and constructively with each other's ideas. A key aspect in the studies that have examined exploratory talk was that students worked collaboratively to share ideas independently from the teacher.

The Talking Counts project (Murphy, Wegerif, & Fisher, 2010), funded by the Esmée Fairbairn Foundation in England, investigated the use of strategies to support exploratory talk with young students aged six to seven years old. Twelve primary school teachers worked with researchers, in a design experiment, to adapt didactic strategies from previous

exploratory talk studies (Mercer, 2008), in order to introduce exploratory talk to these younger students. One aim of the project was to examine the different ways the teachers managed the introduction of exploratory talk with the groups in their classrooms over one school term. Video recordings of group work, prior to the intervention project (pre-intervention group sessions) and at the end of the school term (post-intervention group sessions), provided data on the way the teachers managed the introduction of exploratory talk strategies and on how their approaches to teaching may have changed. Interviews with the teachers, at the end of the school term, provided data on the teachers' views and intentions in introducing the strategies and in managing the group work.

Examinations of the video recordings suggested that the introduction of the didactic strategies, and management of the interaction in group work, was not always as anticipated by the researchers, and did not always appear to support exploratory talk. In this paper three teachers from the project are presented as case studies. The video recordings of the pre and post-intervention group sessions of these three teachers were analysed in relation to the teachers' intentions as revealed in their interviews. The case study analysis provided information on how the teachers used the didactic strategies to transform their approaches to teaching, in order to examine why the intervention may not have happened in the way intended by the research team.

Interaction in the Mathematics Classroom: A Dichotomous View

The use of communication and interaction in mathematics classrooms has been influenced by an orientation towards direct instruction and explicit mathematics teaching, and this has been policy in several countries such as England, the USA, Australia, and New Zealand (Ewling, 2011). This orientation is aimed at improving performance in numeracy by developing a connected view of mathematics, and is supported by a teacher's direct modelling to a class or group of students. A direct instruction orientation has been related to a sociocultural ideology in line with Vygotsky's theories of language mediation (Mertens & Wood, 2000), and suggested a shift away from the construction of mathematical structures through manipulatives by individual students, towards the mediation of mathematical structures by the language of the teacher.

Whilst social in the sense that the teaching comes from the teacher, this ideology rests on a positivist structuralist perspective, where mathematics knowledge relates to stable patterns, or a set of universal invariant structures (Walkerdine, 1990). Modelling by the teacher aims to lead students to a correct interpretation of representations and to make connections between the representations (Ewling, 2011; Sfard, 2001). Although language is a mediating tool, its use is through direct instruction as the "teacher tells the students what they need to know and learn" (Ewing, 2011, p.68). The students' part in the interaction is often to explain their mathematics as a form of strategy reporting (Wood & McNeal, 2003). Hence, talk is seen as a window into the mind of the student; to see if the student has acquired the correct interpretation or representation of the mathematics (Lerman, 2001; Sfard, 2001).

Alternative ideologies, which also align with Vygotskian theories, relate to learning in mathematics from a non-positivist perspective, where knowledge is not seen as a stable body of facts, but as a generative process of meaning-making (Walkerdine, 1990; Wells, 2001). Much has now been written in relation to understanding mathematics from such a social semiotic perspective (Ernest, 1994; Lerman, 2001; Radford, 2006; Seeger, 2011; Sfard, 2001; Walkerdine, 1990; Walshaw & Brown, 2012). Rather than language being a mediating tool in explaining and acquiring a set of correct mathematical structures, language is seen as a mediating tool for meaning-making through the negotiation of ideas. Hence interactions in

mathematics are not just window opportunities to see into individual minds, but are “discursive contributions that may pull others forward into their increasing participation in mathematical speaking/thinking” (Lerman, 2001, p.89).

The pedagogy espoused by the English national strategies focused on students’ acquisition of correct interpretations mediated by the language of teachers’ and students’ explanations. Representations and procedures, modelled and explained by a teacher, were related to students’ internalisation of the teacher’s ideas (Goos, 2004). In guided group work the teacher’s role was to address the needs of students by modelling a representation or method, and then to observe and to question students, in order to make decisions about what the student does, or does not know, in relation to the correct interpretations (Walls, 2005).

Collaborative group work suggests an alternative dialogic pedagogy, where the teacher sets a task that the students work on together independently from the teacher (Alexander, 2005). As the teacher withdraws, interaction is initiated and directed by the students (Kershner, Warwick, Mercer, & Kleine Staarman, 2012). The introduction of didactic strategies, based on the notion of exploratory talk, is intended to support students in directing their interaction effectively. Students are encouraged to challenge each other’s ideas constructively, and to arrive at a consensus when solving a problem. The students’ language is used as a mediator, not in explaining representations that have been modelled by the teacher, but in negotiating the meaning of ideas. Understanding happens within the context of the meanings negotiated between the students’ in their discourse, where the context is set within a problem. In this way psychological processes are shared, with the potential to support conceptual change (Littleton & Mercer, 2013).

Whilst the ideology underpinning the pedagogy of the English national strategies may have been aligned with a Vygotskian perspective in recognising learning as a sociable or collective process, the ideology did not recognise the social character of knowledge and learning (Alexander, 2008). Learning was still seen as the construction of the internalised ideas of the teacher. In comparison, the ideology underpinning exploratory talk aligns with a more social view of Vygotskian theories. Not only is language used to construct ideas (Goos, Gailbraith, & Renshaw, 2002), the social character of learning is also recognised through the construction of ideas as negotiated meaning within the context of a problem.

A Discursive Approach to Analysis

Studies, such as Mercer and Sams (2006), qualified how well teachers performed in developing exploratory talk, and related the impact of their performance to the students’ productive talk and achievement in mathematics. Such studies were technical in their view of knowledge and in assuming that educational processes were controllable (Carr & Kemmis, 1983). Those teachers, who did not develop exploratory talk in their classrooms, were seen as blockages, and it was surmised that, with improved didactic strategies, these blockages could be overcome. Further studies have considered how the development of such a dialogic approach has entailed a transformation of practice by teachers in accommodating a new pedagogy (Goos, 2004; Hunter, 2005). These studies have begun to consider a teacher’s performance from a discursive perspective, and to recognise that a teacher’s understanding of pedagogy is historically, socially, and politically mediated (Walshaw, 2013). In using a new pedagogy, teachers are “making sense of their worlds” (p.82), where their worlds are based on the relationships each teacher has with mathematics pedagogy.

Ideologies characterise teachers’ thinking in understanding their worlds and predicting their behaviour. Differing ideologies are underpinned both ontologically, in viewing what mathematics is, and epistemologically, in viewing how we come to know

mathematics. Hence, ideologies related to mathematics pedagogy are constructed in teachers' world views and are themselves "discourses that categorise the world in ways that legitimate and maintain social patterns" (Jorgensen & Phillips, 2002 p.108). So, not only do teachers' discourses relate to ideology, the ideologies themselves relate to discursive representations of reality that are historically and socially bound.

The three case-study teachers presented in this paper would have gained their initial training, and any further professional development, at a time when the English national strategies were the received curriculum, and, so, the teachers would have been exposed to the ideologies espoused by the policies of these strategies. These ideologies differed from the ideologies of exploratory talk, but both ideologies were discourses that legitimated and maintained social patterns.

In working with the teachers to introduce exploratory talk, the project would require the teachers, not only to make pragmatic changes in managing group work, but also to make a shift in ideologies. Furthermore, the differing ideologies of the national strategies and exploratory talk suggested a potential pedagogical dichotomy (Alexander, 2008), and such a shift in ideologies may have introduced predicaments for the teachers. In analysing the video material, in relation to the teachers' discourse in their interviews, any perceived predicaments were seen as "the social consequences of different discursive representations of reality" (Jorgensen & Phillips, 2002, p.21). That is, predicaments were not viewed from a technical viewpoint, but as discursive dissonances related to the teachers' subjective realities. The aim was to view the constitution of their experiences in introducing exploratory talk as both historically and socially mediated.

The Research Project

The Talking Counts research project was based on a design experiment (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). The teachers attended an initial research meeting with the research team, where they were introduced to the notion of exploratory talk following work from previous exploratory talk studies with older ten to eleven year-old students (Mercer, 2008). Didactic strategies, to support the introduction of exploratory talk from the existing studies, were presented and discussed with the teachers, with the intention that the teachers adapted these for younger, six to seven year-old students in their classrooms. The teachers' use of these didactic strategies, and the development of mathematics tasks, were shared and reviewed in two further research meetings.

In reviewing the development of the teachers' approaches, the strategies for developing talk and managing the group work fell into three main stages. In Stage One the teachers made explicit their intentions of how they wanted the students to talk together in their groups. They did this by raising the awareness of talk and encouraging active listening using a range of tasks such as circle time, drama, and use of puppets to model good and bad talk and listening. Students made lists of talking words (chatting, sharing, explaining, moaning, and so on) and held class discussions on the sort of talker they were; quiet or talkative. In Stage Two the teachers created, in agreement with their students, a set of prompts that were made visible to the students as they worked in a group. An example list of prompts is set out here.

- Why don't we try this?
- Do you agree?
- What do you think we should do?
- Is that right?

- How about?
- I have a different idea.
- What else could we do?
- So do we all agree?
- I am not sure can you help me.
- Why do you think that?

The teachers introduced the use of prompts with the students as they worked in groups across the curriculum. A key part of exploratory talk, and one that the teachers were asked to emphasise with their students, was reaching a consensus. In Stage Three the ground rules or prompts were focused more closely on group work in mathematics, and the teachers were asked to develop mathematics tasks that they thought would be appropriate for their students and would support collaboration in group work.

Twelve teachers were involved in the project. In each class the teacher focused on six students. The six students worked in two triads as they engaged in collaborative group work at least twice a week over three months. A video recording of mathematics group work in each class was carried out at the very beginning of the project, before the initial research meeting (the pre-intervention group session). Another video recording was carried out at the end of the school term, when the teachers had moved to the Stage Three focus on the mathematics tasks (the post-intervention group session). The video recordings were transcribed, and the interactions between teacher and students, and between students, were examined in the transcriptions. The intention was to determine any changes in the teachers' and students' interactions from the pre-intervention and the post-intervention group sessions.

The teacher interviews were carried out at the end of the school term. The interviews were semi-structured and were set around questions related to:

- reasons for joining the project;
- how they introduced talk in their classroom;
- how the use of talk had changed their teaching of mathematics;
- if they felt the development of talk had an impact on the students as learners in mathematics; and
- if they would use this approach in future teaching.

Analysis in this paper focuses on three of the twelve teachers involved in the study, Angie, Jenny, and John. These three teachers were selected because they had not used exploratory talk in their mathematics teaching previous to the intervention. The three teachers were also experienced teachers of young students. Angie had been teaching for nine years, and the majority of these years had been with students aged six to seven years old. Jenny had been teaching for eight years with students aged six to seven years old. John had been teaching for eleven years, five years with students aged six to seven years old and six years with new entrant classes (aged five years old). In all the classes the students were mixed ability; they were not streamed for mathematics classes.

Transcriptions of the video recordings of the pre-intervention and post-intervention group sessions were used to provide descriptions of the talk, and of the actions taken by each of the three teachers and their students during group work in their classrooms. These descriptions were then related to the teachers' interviews at the end of the term.

Angie: Case study one

Angie: Pre-intervention Group Session

In the pre-intervention session six students were sitting around a table. Each student had their own worksheet. The task involved the use of coins to support counting in tens and ones as an aspect of place value. Angie was present throughout the group work.

1. Angie: We're going to have a look at the sheet together. You look at the sheet, ok. We've done the first one haven't we? We talked about the fact that it's two tens, here they are, and three units. So, you can see them on the paper, and now you can see them on the table. So, two tens and three units. How did we count that though? Which numbers did we start with? Right, so, we would start with the ten. So, we go ten...
2. Students: ...Twenty, thirty...
3. Angie: Now, this is tricky because we've got to remember that now we swap from counting in tens to ones. So, we've got ten, and then twenty, and then, what's one more than twenty?
4. David: Twenty-one.
5. Angie: Now who can tell me which coins I need for the one underneath? (*Angie points to the next example – 35p*) Which coins do I need? How many?
6. Jill: Three tens and...
7. Angie: Three tens...
8. Jill: ... And one unit
9. Angie: And how many one pence pieces?
10. Jill: One, two, three, four, five.
11. Angie: Ok, I've got three. How many more do I need? I've got three there. How many more do I need? I've got three. How many more do I need?
12. David: Two more.
13. Angie: Two more, good boy well done. Right, have a look. Let's see if we can count them up. Ten...
14. David: ...Ten, twenty, thirty.
15. Angie: Right, that's the tens done. So, what have we got to count in now?
16. David: Ones.
17. Angie: Ok, so, on thirty...
18. Students: Thirty-one, thirty-two, thirty-three, thirty-four, thirty-five.
19. Angie: How do we write thirty-five pence? How do you write thirty-five pence?

The students then worked on some examples individually within the group. Angie then asked one student to explain how many coins were needed to another student.

20. Angie: Ok, right. I'm going to put somebody in charge. I think I'm going to put Claire in charge now. Claire, can you tell Jill how many coins she's going to need and which ones she's going to need? Right, you all need to watch. Tell Jill which coins she needs.
21. Claire: She needs a ten, a one, and a one, and a one, and a one.
22. Angie: How else could you have said that? You didn't need to say and a one, and a one, and a one, and a one. How else could you have said that?
23. Claire: Ten and four ones
24. Angie: Good girl, well done. You could have said one ten and four ones. Let's see who's in charge next time.

In transcript lines 1-19, Angie gave explicit guidance on what to count and how to count. Angie questioned the students on what the next count would be, and they followed her

directions in completing the counting. In transcript lines 20-24, Angie put a student, Claire, in charge, with the intention that Claire directed Jill. However the purpose of being in charge was not clear. It did not seem that Claire was directing Jill in what to do, as it was Angie who questioned Claire and suggested a more efficient way to give the direction. So this may have been an attempt to see how well Claire had interpreted Angie's instructions, rather than an attempt to engage the students in an interaction.

Angie: Post-intervention Group Session

In the post-intervention session, three students, Emma, David, and Jill, were working in a group. The task involved determining the value of coins, and Angie had placed a collection of coins on the table in front of the three students. Angie was present throughout the group work.

1. Angie: So, I'm just going to tip the money out so you can see it. You don't need to take any yet, alright. And what I'd like you all to do, ok. You see all the coins, which is the biggest value coin you can see?
2. Emma: Two pounds.
3. Angie: Two pounds. So, shall we put that here? Daniel, which is the next biggest value?
4. David: Fifty.
5. Angie: What do you think Jill?
6. Jill: One pound.
7. Angie: Do you agree David?
8. David: I agree.
9. Angie: Do you agree that a pound is bigger than a 50p?
10. Emma: Yes.
11. Angie: Ok. Can you fill in the rest for me please?

Angie asked the students to take turns placing coins, in order of value, in a line on the table in front of them.

12. Angie: Now, let's just have a look. Where have you put the five pence? It's got to go in the line don't forget. Where is it going to go again? Where does the five pence go?
13. Jill: With the two.
14. Angie: Let's have a look shall we. We've got two pounds, one pound, fifty pence, twenty pence, ten pence. What comes next?
15. David: 2p, 5p goes in between there.
16. Angie: Ah, how do you know that?
17. David: Because five is a bigger number than two.
18. Angie: Good boy. Five is a bigger number than two, isn't it?
19. David: I put it right, didn't I?
20. Angie: Well done.

Again, Angie directed the interaction and talk in the group. In transcript lines 7 – 10, Angie asked the students if they agreed on the order of the coins, and so referred to a key prompt from the exploratory talk didactic strategies. However, it is not clear if she intended the students to reach a consensus, or if she was using the prompt to determine the students' recognition of the value of the coins. In transcript lines 12-20, Angie asked David directly why he placed the five pence coin next to the two pence coin. She did not encourage the students to explain their decisions to each other, but to her. So, again, Angie may have been

using the talk to determine the students' understanding, rather than for the students to share ideas with each other.

Angie: Interview

Angie explained that she had not used exploratory talk before the project, although she had focused on students' speaking and listening skills through aspects of her teaching. Angie indicated that the students in her class were young and "socially and educationally needy." Angie felt that the students were beginning to use the prompts for talk that she had introduced, but that the development of the students' talk would take some time. As she said, "They [the students] need constant reminding about lots and lots of things, like hanging up their coats, so, I think it [the prompts for talk] will go in." Even so, Angie felt that a different use of talk was "filtering in" to the students' interactions. She stated that in whole class teaching the students "brought the talk to the carpet." She further added that, "They're more giving actually, you know, they'll talk about maths more now I think."

Angie explained that she needed to stay with the students and direct the teaching for two reasons. First, she did not feel the students would be able to talk to each other independently from her, "Because they haven't got that independent thinking and life experience." Second, she felt that she was, "Supposed to be teaching them. You're supposed to be taking them a step further to the end of their learning, and not just sitting and doing an activity." Angie was clear that she needed to be explicit in directing the students' mathematical ideas. "It's more you telling them and probing them, and almost giving them the answers that you want to hear."

Angie was positive about the intervention. She felt it had benefited her teaching and the students' learning. She talked about the group work as "more focussed and forward moving," and that the focus on talk had helped with her assessment of the students' learning. "You kind of walk away from them and you think, yea, they got that. That helps inform my ongoing assessments."

Angie: Summary of Case Study One

Angie had not used the ideas from exploratory talk to encourage collaboration between students as had been anticipated in the research project. If we were to comment on the quality of Angie's performance from the transcript extracts, we would consider that she had failed to develop exploratory talk. In both group sessions, Angie questioned the students about what to do next and in seeking the students' reasoning. In the pre-intervention transcript, Angie was more explicit in counting with the students, and in the post-intervention transcript she seemed to be asking their views ("Do you agree?" (lines 7 and 9)). There was a suggestion she was sharing the problem with them ("Let's have a look" (lines 12 and 14)), but there was no interaction between the students. There was little evidence of the use of the prompts, apart from the transcript lines where Angie asked if the students agreed, but then the consensus did not appear to be between the students. In both the group sessions, the talk was directed by Angie to model the mathematics, and the students used talk to explain their thinking to her.

As such, there seemed to be little change in Angie's approach to managing the interaction in group work. In the interview, Angie indicated that she saw herself as responsible for the direction of the students' learning. Angie indicated that she did not see the students as capable of their own thinking, and that it was her responsibility as a teacher to take the students along predetermined steps of learning. Even so, Angie was positive about

the project. She saw the value of the project in helping the students to talk further about the mathematics to her, and, so, help her in assessing the students' learning. Angie talked about the students "bringing the talk to the carpet". The use of the word 'bringing' suggested that Angie saw the talk as being integrated into an existing pedagogy of directed teaching. Her use of the phrase "they're more giving actually," suggested that the students were more willing to report their thinking to her. As she stated, she could walk away from a group with a better view of their thinking.

In both group sessions the students were being asked to internalise Angie's ideas. This approach to teaching was reflected in Angie's discourse regarding what a teacher is supposed to do, and reflected the ideology of the national strategies. Angie did not seem to have any predicaments with the ideological dichotomy of the national strategies and of exploratory talk, but had adapted the didactic strategies into her existing pedagogy with no ideological shift.

Jenny: Case Study Two

Jenny: Pre-intervention Group Session

Before the group session, Jenny modelled to the whole class how to identify and circle the key terms that related to a calculation in a word problem. Three students, Lucy, Jane, and Ann, then worked in a group independently from Jenny. Each student had their own worksheet for recording, but Jenny had instructed them to work together. Lucy read out the first problem.

1. Lucy: There are sixty sweets in a bag, twenty sweets are red. Sixteen sweets are yellow. The rest are green. How many sweets are green? So how do we work it out?
2. Lucy: So sixty take away two,
3. Jane: No twenty, you add these. You add twenty and sixteen together then you count on to sixty.
4. Ann: That's what I think
5. Lucy: Thirty, twenty-nine, twenty-eight, twenty-seven, twenty-six, twenty-five, twenty-four.
6. Lucy: Just let me write the answer down somewhere.
7. Jane: But you need to show how you worked it out.
8. Lucy: No you don't.
9. Lucy: No, no, no. You're not allowed to do that. You've got to work it out yourself.
10. Jane: I worked it out myself.
11. Jane: Ok, there are sixty sweets in the bag, twenty sweets are red, sixteen are yellow, the rest is green. How many sweets are red? How many sweets are green? I'll show how you work it out.
12. Lucy: I've done it! Easy peasy, lemon squeezy. I'm finished already.

Jenny then joined the group of students.

13. Jenny: How are you doing here? So you're doing this one. So did you get the important information?
14. Lucy: Yes.
15. Jenny: It's quite useful to put a little ring around the important things. So, we've got, how many sweets in a bag?

16. Lucy: Sixty.
17. Jenny: So if we just look at who... This was yours Lucy? So you started with sixty?
18. Lucy: Yea.
19. Jenny: Why have you subtracted twenty?
20. Lucy: I took away twenty because twenty are red sweets.
21. Jenny: So you take away the red sweets? Brilliant!
22. Lucy: And then you take away the yellow sweets.
23. Jenny: And then you took away the yellow sweets.
24. Lucy: And that left me with twenty-four.
25. Jenny: And that left you with, right. So, this was your calculation?
26. Lucy: Yep.
27. Jenny: How did you do that calculation?
28. Lucy: Well I had sixty in my head, then I took away twenty, which got me to... It got me to forty.
29. Jenny: So you did that bit in your head then?
30. Lucy: Yea. Then I took away ten, because I knew that one was ten, and then I took away six from thirty, and then I got to twenty-four.
31. Jenny: That's amazing Lucy!

Even though the students had been asked to work together, they did not solve the problem together, or agree they had the correct solution. In transcript line 3, Jane gave directions to the other two students on how to calculate the solution, but they considered it important to record their own way of working. When Jenny joined the group she reiterated how they should circle the terms related to the calculation in the word problem. She also asked the students to explain their calculation strategies. As such, she asked the students to report their thinking to her, in relation to her modelling, and also in their calculation strategies. There was no suggestion that they should explain their thinking to another student in the group.

Jenny: Post-intervention Group Session

Before the group session, Jenny reinforced the ground rules for talk with the whole class. Jenny explained the task, but did not model a strategy. Again, Lucy, Jane, and Ann worked independently of Jenny. The students were working on a problem based on a square grid of dots. The grid represented an area of ground, and the students were to imagine that a worm would eat the earth in each square of the grid every day. Some squares were blanked (see figure 1), and these represented the squares that the worm had eaten, one square a day. The students were asked to work out how many days it had taken for the worm to eat these squares. Each student had a sheet with the square grids, but there was only one sheet with the explanation of the problem and space for recording their solution.

28. Lucy: Yeah.
29. Jenny: Well we've been counting in fours haven't we? Could we use our counting in fours?
30. Lucy: That's gone down in a five, 'cos one, two, three, four, five.
31. Jenny: So it's five lots of?
32. Lucy: Four.
33. Jenny: Ooh, what's five lots of four?
34. Lucy: Thirteen?
35. Jenny: See if you can work it out using groups. So, if you think about how many you've got in a group, and how many groups you have. Have a little chat and see if you can work it out that way. I'll leave you to have a little think and talk together.

Jenny then moved away, and the students turned their attention to another problem on the sheet.

It appears that the students were relying on counting the blanked squares, and, in the transcript lines 1-8, the students gave different solutions from their counting. The students acknowledged their inability to arrive at a solution together. They claimed this was not a disagreement but that they were confused. In transcript line 25, Jenny asked Lucy to explain her thinking to the other students. Jenny acted as an intermediary, in that the students gave their explanations to her, rather than to each other (lines 26 to 34), but this did appear to be an attempt by Jenny to help the students arrive at a consensus. Jenny prompted the students to look at the grid array, and Ann and Lucy noted between them that there must be five rows of four squares missing. Jenny then left the students to find the solution themselves and, again, prompted them to use their existing knowledge to skip count in fours. However the students did not complete the problem.

Jenny: Interview

Jenny had focused on classroom talk prior to the project, and in particular the use of 'talk-partners' as a strategy in all subject areas for "kind of bouncing off each other in that way." However, she saw exploratory talk as different from the talk she had used previously in the classroom. She felt that the quality of the students' talk had changed over the intervention, and that this was due to her move away from group work where, "They would work on their own piece of work individually, kind of in the group."

Jenny wanted to support the students in talking together independently, to deal with constructive challenges, and to share ideas. She admitted that this had not been easy. "I found it quite an eye-opener in how complex it all is." In particular, she commented on the difficulty some students had in disagreeing with each other. The students saw disagreement as conflict and negative. The students thought they would upset someone, and that this was "at odds" with collaboration, where "everybody must be comfortable in the group." In order to help the students overcome this, Jenny had concentrated on "disagreeing in an effective way," or "a kind of polite way, so you're not actually hurting anybody's feelings."

Jenny was keen that everyone should have a chance to say what they think. She had promoted the idea that the quiet person might have "the best idea of all" and that, "The group is being short-changed because they're not having what could be potentially the best idea." Jenny felt this had been a "revelation" to some of the students and that, "It's been quite an empowering rule for, especially the quieter students, is the rule that everybody must say something."

Jenny questioned whether collaboration was possible with students from a range of abilities. She was uncertain how to develop tasks and find activities that were accessible to the students, but that also set a challenge. She was concerned that the students did not always arrive at a solution together, and that they found this frustrating, “Because they can only go so far with it, and I think the natural feeling is that they want to find the answer. They want to get to the end, but they don’t have the ability to do that.” She talked about the students feeling “unfinished, which I don’t think is very good for them.”

Jenny’s reaction to the students’ learning was mixed. She was uncertain if she should leave the students to work independently in her future teaching, “Because it’s no good letting them talk and I don’t know what they’re doing. I’ve got to be there to monitor it.” Whilst Jenny seemed committed to the idea of exploratory talk, she said she would modify use of the talk in guided group sessions with future classes.

Jenny: Summary of Case Study Two

From the video transcript excerpts and the interview, it would seem that Jenny had attempted to transform her teaching. Jenny was concerned to reinforce the prompts for exploratory talk, and her main emphasis was to encourage the students to agree on the same solution, rather than to work as individuals within a group. However, from the research project perspective, Jenny had not been successful in developing exploratory talk in group work. In the post-intervention session the students did not share their ideas independently of the teacher, only their solutions.

A change was apparent to some extent in the two group sessions. For example, Jenny did not model a procedure for solving the problem in the post-intervention group session, as she had in the pre-intervention session. When Jenny interacted in the post-intervention session, she encouraged the students to share ideas (“and Lucy lets you know why she thinks sixteen” (line 25)) and prompted them to make connections with multiplicative thinking, rather than asking the students to report their strategies to her. Even though the students directed their explanations to Jenny, the responses from both Ann and Lucy, in determining five rows of four, suggested that the two girls did share ideas, with Jenny acting as the intermediary. This interaction was different from the pre-intervention session, when Lucy reported her calculations, and none of the other students responded to the explanation. The attempt by Jenny to act as an intermediary in supporting the students in exchanging ideas, was indicative of the development of collaborative work. However, it was not clear why the students did not then develop these ideas together to find a solution. It seemed the idea of being left to ‘have a little chat’ (line 35) did not mean anything to the students.

These changes were reflected in Jenny’s interview, where she stated how the contribution from all students was empowering, and how she felt there had been a difference in the way she talked with her students. However, Jenny did seem to be experiencing a predicament. On the one hand she talked about empowerment and challenge afforded by the change in group work, but on the other hand she felt that her role was to monitor the students’ thinking. She was concerned that the students could not always arrive at a firm solution to a problem without her being there. The students’ inability to understand what ‘chat a bit’ meant may have been reflected in Jenny’s views that talking about mathematics still meant reporting their ideas to their teacher, and not negotiating meaning between each other.

John: Case Study Three

John: Pre-intervention Group Session

John was working with a group of six students. John placed ten 10-piece Numicon on the table in front of the students.



Figure 2: Ten 10-piece Numicon

1. John: So, how many's there?
2. Students: One hundred.
3. John: So, how many lots of ten?
4. Students: Ten, ten, ten.
5. Mary: (*Points to each Numicon.*) Ten tens.
6. John: Mary, can you take four lots of ten for me? (*Mary takes four Numicon.*)
7. John: How much has Mary got altogether?
8. Students: Forty.
9. John: How many has she left behind?
10. Pierce: Sixty.
11. Students: Sixty.
12. John: She's left sixty behind. Ok then. So, if Mary adds her forty back to the sixty, what will we have?
13. Jack: One hundred.
14. Students: One hundred.
15. John: We're gonna have a hundred aren't we. Can you (*to Mary*) put them back a minute? Fran, can you take seventy for me? (*Fran takes seven Numicon.*)
16. John: Does everyone agree with that?
17. Students: Yeah.
18. John: Why do you agree with that Pierce?
19. Pierce: Because, you can see, if you add them all up, you can see there's seven tens. And if you add three to it, it makes one hundred. If you do it the easy way you just add seven and three to make ten.
20. John: Seven add three make ten. Why are you doing seven add three makes ten?
21. Pierce: It makes it easier...
22. John: ...Makes it easier. Remember, we did that last term. We were thinking weren't we, that, if you know seven and three makes ten, it helps you work out seventy add thirty. That's well remembered, brilliant. Let's put them back together again. How many have we got now?
23. Students: A hundred.

24. John: Can you (*to Jack*) take six tens for me. If he takes six tens, how many is going to be left behind? (*Jack takes six tens.*)
25. Students: Four.
26. John: But why? Iris can you explain why?
27. Iris: Because four add six equals ten.
28. John: Because four add six makes ten. I said take away, and your using your add. Do we all agree? Has he left four behind?
29. Students: Yes.
30. John: He hasn't left four behind. He has left four tens. He has left...
31. Students: Forty.

John directed the talk and the number of Numicon pieces to remove each time. John's questioning was mostly closed, and focused on checking the students' understanding and knowledge of the addition of decade numbers to one hundred. Only in transcription line 18 did John use a procedural question in asking Pierce why he had agreed. Pierce's response was directed to the teacher in reporting his strategy ("the easy way" (line 19)). John acknowledged this as a strategy they had met before, and another student also used the strategy. So, Pierce's idea had been shared with the rest of the group. John asked the students if they agreed, but this consensus seemed to be for John to check their understanding, rather than to encourage interaction between the students. John's direction to the students in transcription line 30 to refer to four tens and not four, would suggest he was determining if the students had internalised his ideas.

John: Post-intervention Group Session

At the start of the session John sat with three of the students from the previous group, Jack, Mary, and Iris, and John set a challenge for them.

1. John: Ok. Here's the challenge for you. (*John writes* □ □ 10.) What does it say? Something is more than...
2. Students: Ten.
3. John: Ok. I'm going to write this number down. I'm going to write seventy. Seventy is more than ten. Right you go. When you write down a number, tell them why you chose that number.

John leaves the students as they take turns in writing numbers.

4. Jack: It's easy. There's like a trillion numbers in the world.
5. Iris: There's a thousand.
6. Jack: No bigger than that. It goes on.
7. Iris: And never stops. Like a billion, but I've no idea how to draw that.

John returns to the group and positions himself behind the students. He points to one of the numbers (ninety) that the students have written.

8. John: Why is ninety bigger than ten?
9. Mary: Because it's further on, on the number line.
10. John: Ok. Now what we're going to do on here? Look, I'm going to put a line down the middle, and I'm going to change it now. (*John writes* □ □ 10.) What does it say now?
11. Students: Something is less than 10.
12. John: Ok. What could go in the box this time?

13. Mary: Seven.
14. John: Go on then, put it down. We'll go round the other way. Go for it.

John leaves the group.

15. Jack: There's hundreds.
16. Mary: There are thousands. No it's not. Ten, nine, eight, seven, six, five, four, three, two, one.
17. Iris: Just imagine, minus one, minus two ... minus nine. (*Iris laughs.*)
18. Mary: It's my go, five.
19. Jack: Four.
20. Iris: Three.
21. Mary: Two.
22. Jack: One.
23. Iris: Zero.
24. Mary: How do you do minus one?

Students are laughing and continue to take turns to write negative numbers.

25. Jack: Is that supposed to be ten?
26. Iris: It doesn't matter, minus ten.
27. Jack: Shall I do minus twelve? Minus twelve.
28. Iris: Now what are we on? Minus thirteen.
29. Jack: Where are we? Minus fourteen, minus fifteen.

John returns to the group. There is lots of laughter from the students.

30. Mary: Hide it, hide it. (*The students shield the paper from John's view with their hands.*)
31. John: Ok. Let's have a look. (*The students take their hands away.*) What, wow!
32. Iris: We're all working together.
33. John: Wow, that's great, can you explain the negative numbers for me?
34. Iris: We just used nine, eight, seven, six, five, four, three, two, one, zero, minus one.
35. John: Why is minus five less than ten? Do you want to show me on the whiteboard? Do you want to show me? Can you show me? Why is it less than? Do you know why it's less than? No? Can you explain to me why it's less than?
36. Iris: (*Iris takes a whiteboard and pen.*) Well, I'll just do a line, there's zero, and here is minus one, and I don't know where ten is...
37. Mary: (*Mary points to the line Iris has drawn on the whiteboard.*) Zero one, two, three, four, five, six, seven, eight, nine, ten.
38. Iris: And here is ten. So, there's zero and it's before, and it's behind.
39. John: Alright. So, it's going down that part of the number line. So, how many numbers could keep going that way then?
40. Iris: More than a hundred, I think.
41. John: More than a hundred, how many?
42. Jack: A gillion.
43. John: That's a good number, a gillion.
44. John: Alright then. So, which one's going to have more answers? (*John points to the two sides – more than and less than.*)
45. Jack: That one. (*Jack points to the 'more than' side.*)
46. John: That one. Which one do you think Mary?
47. Mary: I don't know.
48. John: You're not sure?

49. Iris: I think both.
50. John: You think both are going to...
51. Iris: Yes, they're just going to go minus, minus and like... Just like one, there's minus one. So, it's just going to be the same, but starting off with minus.
52. Teacher: Fantastic, alright then, that's fantastic. I actually think we'll stop there today for that.

In this post-intervention group session, John was present in the group initially to check the students knew the inequality signs, but he left the students once he had set the task. There was little interaction between the students as they took turns in writing numbers, even though John had asked them to explain why one number was bigger. Instead the students were sharing ideas about the number of possible solutions. When John returned to the students, he questioned them to check their understanding of the ordering of the numbers ten and ninety (line 8). John then changed the task and he left the students again. This time there was interaction between the students, not in explaining why one number was smaller than ten, instead they shared ideas in realising they did not need to stop at zero. Mary's initial idea that you could only have the numbers from ten to zero was changed, when Iris suggested they imagine minus one and minus two (line 17). The students took Iris' idea on board and worked together to extend the negative numbers, asking each other for help in how they might write them. When John returned, the students were laughing and hid their work, as if it were some trick they were playing. John questioned the students to check their understanding of negative numbers. Whilst this questioning was still directed by him, and the students responded to him, they were clear that they had worked together. Furthermore, Mary and Iris collaborated in explaining why negative five was less than ten. When John asked if they could determine which inequality would have more solutions, the students answered individually with their ideas.

John: Interview

John explained that he had focused on students' use of speaking and listening in his classes, but he felt that the idea of exploratory talk was different, and introduced a new perspective in his teaching. He felt that exploratory talk was more focussed, and that it gave him a structure to encourage the students to talk and to say, "Right this is why we talk to each other." He felt the students were seeing a benefit in talking to each other, particularly with the lower achieving students, where it helped them to explain what they were seeing and to listen to each other. He gave an example of one student, "It was really interesting, little Jake sat down on the carpet, and he's just going like this, just talking and talking about three lots of four and things like, and he's thinking." John acknowledged that the talk was where the "maths happens," and that this could happen without the teacher's ideas.

John felt that he had transformed his practice, but that this had been "natural." He described how he had previously worked with guided groups, "Pretty much with me there instigating the talk, you know, sat there in the middle of them, leading the talk to be honest with you." Following the intervention, John felt that he was more like a facilitator. He described his new role as, "Kind of stepping out and stepping in," and that he was, "Free to observe and move away." John also commented how his planning and preparation of tasks had changed. John had looked for more open-ended tasks that would encourage the students to think further so that they did not, "Just sit there and go like that, and do it..." He also focused more on his use of questioning in his planning, and would consider, "What could I ask them? And why are you asking it? It makes you think how you're talking to them."

However, John indicated some tension in questioning the students. Whilst he felt his questioning would intervene in the students' thinking, he wanted to gain a real insight into how the students were thinking. He used the phrase "You want to know" about the students' thinking. John was keen to continue to develop his use of talk in group work in future classes. He talked about his students having "a buzz for mathematics," but he also hoped he could extend their independence further in finding their own mathematics challenges.

John: Summary of Case Study

Both the transcripts of the group sessions and the interview suggested John had made a shift in his teaching approach. John talked about the change being natural for him, and he stated that he was free to focus on the student learning, rather than on directing and modelling the mathematics. He was now sitting back, watching, and listening to the students, rather than instigating the talk. From the perspective of the research project, the students did not elaborate their explanations to each other, but they did collaborate and share ideas.

In the pre-intervention session, John had directed the talk. His questioning was closed and checked the students' understanding. Whilst John did take an idea from one of the students and share it with the rest of the group, he was encouraging them to internalise the idea. In the post-intervention session, John withdrew from the group for part of the time, and there was evidence of the students directing the talk and the mathematics without John being present. Whilst John may have intended the students to use negative numbers, it seemed that the students arrived at this use themselves and negotiated a systematic way of recording the numbers together. This negotiation in the group had not been evident in the pre-intervention session.

In the interview, John suggested that mathematical thinking was happening as the students talked, and that talk was not just to report strategies. John's use of speculative questioning in the post-intervention session seemed to be a genuine inquiry into the students' thinking, rather than asking them to report a strategy they had been taught. However, John did acknowledge some tension regarding wanting to know about the students' thinking and how much his questioning might intervene in the students' talk.

John talked about his transformation of practice as natural, and that, in this changed practice, he was free to observe and move away. Although he may have directed the talk in group work prior to the intervention, as was expected in guidance from the national strategies, John felt able to move away from this practice. John still felt concern that he should be monitoring the students' thinking, but he also acknowledged how the thinking was happening in the students' independent talk.

Discursive Analysis of the Three Case-Study Teachers

Whilst all three teachers had attended the research meetings and used the didactic strategies to encourage exploratory talk in their classrooms, review of the group sessions suggested different shifts in their practice.

There seemed to be limited transformation in Angie's practice. Angie remained present and continued to direct the talk in the group work. As regards the intentions of the research project, Angie had not been successful in supporting exploratory talk with her students. There was little genuine need for the students to share their ideas. However, Angie did not see any tensions in this. She had adapted the strategies for exploratory talk and saw that the students brought the talk into her existing classroom practice. Her ideological

orientation was towards directed teaching. In her view, directed teaching was what a teacher was supposed to do. The students would not be able to think the mathematics independently from her, and she needed to make the mathematics explicit to them so that they could internalise her ideas. Her impression, of how the intervention had supported the teaching and learning in her classroom, was that the students could give more in their explanations to her. That is, they were more willing and able to report back the ideas that she had made explicit.

Jenny had seemed very supportive of the development of exploratory talk in her classroom, and she emphasised how the students should talk together before group work. However, as regards the intentions of the research project, Jenny had not been successful in supporting exploratory talk with her students. The students seemed unable to share their ideas within a group; only to tell each other their solutions. The students in the post-intervention session were unable to complete the task. Jenny was aware of this. She admitted that she had found the development of exploratory talk to be complex, and that finding tasks to challenge the students was difficult. Jenny appeared to experience tensions between the two teaching approaches. Whilst she acknowledged the empowerment of her students to share ideas, she was also concerned that she needed to be there to monitor these ideas. So, whilst she had some notion of students' independent thinking in mathematics, this notion was counter-pointed by her concern that the students' thinking was correct.

In contrast, John's change in practice suggested a transformation from directed teaching towards a dialogic approach. As regards the intentions of the research project, John had supported productive talk and collaboration with his students. The students negotiated meaning together in a group and shared ideas. John talked about the transformation of his practice as natural, suggesting that the idea of dialogic practice fitted with his ideological position. He acknowledged that the students talk was where the mathematics thinking happened, and that he was concerned he should not intervene to stop this thinking. As such, he did not see any predicaments in transforming his practice. John used terms such as being free to move away, and these terms may have indicated that he felt less tied to direct teaching.

Whilst Angie had adapted the talk into her ideological position and teacher identity, Jenny felt tensions regarding the pedagogical dichotomy between students' independent thinking, and arrival at the correct set of mathematical ideas. For Jenny, the ideology of the research project caused tensions with her ideology of teaching. Meanwhile John had been able to merge with a new teacher identity. It was almost as if he had been freed from the need to direct students. Whilst he saw it was important to know what the students were thinking, this importance related to a desire to know how the students understood a mathematics concept, rather than to report back a strategy. As John felt that the transformation in his teaching was natural, he had not seen any tensions with the ideology of the research project.

There has almost been an assumption that, in a design experiment, the teachers should adopt the philosophy of the research project and change their practice in a way that is anticipated by the research team. If not, then it is almost as if the design experiment was not successful with some teachers, and that these unsuccessful teachers may not have had the same commitment to the research (Mercer and Sams, 2006). This technical position does not seem acceptable in explaining the variation demonstrated by these three case-study teachers. All three teachers were positive about the intervention and seemed dedicated to the idea of developing talk in their mathematics teaching. All three teachers commented that the focus on talk in the project was different from any previous focus on talk in their classrooms. They were all engaged in the discourse of the research project, in that they used the didactic strategies in their classrooms. They felt that these strategies had helped the students to talk more, and that more students were involved in the talk. The encouragement of communication and interaction in mathematics classrooms had been a focus of policy

guidance as well as a focus of the research project. Furthermore, the teachers had joined the research project because of their interest in use of talk. So this positive reflection would not seem surprising.

A discursive perspective can better help explain the variations in shifting practice by considering the teachers' different interpretations of the purpose and use of productive student talk in their classrooms. These interpretations of student talk are seen as constructions of the teachers' ideological positions that acted as key factors in how they participated in the intervention project, and in how they discussed the intervention in their own classrooms. The ideology of the research project was to encourage student-student interaction in relation to a dialogic view of learning as negotiated meaning-making, rather than the internalisation of the teachers' ideas. A shift in practice with regard to this dialogic ideology seemed to happen only in John's use of group work.

One key variation, that became apparent in the teacher interviews, was the teachers' views of students as learners, and how these views impacted, not only in the way they introduced and supported the use of talk, but also in their expectations of the students as participants in mathematics conversations. Could young students really be trusted to engage in productive talk independently of the teacher? Angie had felt that her students were unable to think independently, and Jenny was concerned that the students would arrive at correct solutions. John's ideology was different. For him, the talk was where the thinking happened, and this thinking not only could, but should, happen without him intervening. Another key variation aligned with the teachers' views of their role in teaching mathematics. Angie was clear that a teacher is supposed to direct the students' thinking, and Jenny was concerned that she should be there to monitor the students' thinking. John's view was that he wanted to know about their thinking, but that he could move away from the direct teaching and observe to do this.

In analysing the interviews, the teachers' discourses about their practice were interpreted as the construction of their world view and as a social action, where that social action presented an ideological position, from which the teachers both participated in, and evaluated, the discourse in relation to the intervention in the research project (Wodak & Meyer, 2009). Angie's views suggested a structuralist perspective of mathematics learning, where students acquire a stable view of mathematics. This view was commensurate with the existing discourse of the national strategies. The further use of talk provided her with a clearer window on the students' thinking, so that she could determine the students' thinking and acquirement of representations. John's comments suggested he was not just using the talk as a window on the mind, but as a way of thinking, and this view would be commensurate with a dialogic perspective and non-structuralist view of learning in mathematics. As such John's ideology appeared to shift away from the existing discourse. Jenny's conflict suggested she was torn between the existing discourse and the dialogic ideas from the project. This conflict seemed to come from wanting to comply with the ideology of the project. She had noted the idea of student empowerment, but her views of mathematics learning may have pertained to a structuralist perspective. Whilst the students could be empowered, she needed to be there to make sure the students arrived at the correct ideas.

Discussion and Concluding Remarks

Interpreting the teachers' actions in managing the group work, and their discourse from the interviews, has provided a view of the three teachers' worlds and how they were making sense of their worlds, as they approached a new way of teaching (Walshaw, 2013). From a discursive pedagogical perspective, the variations in the way the teachers altered their

practice can be explained by the way the teachers saw the different pressures from different discourses. As such, none of the three teachers ignored what was asked of them, but they did interpret the use of exploratory talk in their classrooms in different ways.

Hanley (2010) commented how teachers have regard for discourses from a research project, as well as from national frameworks and policies. There are often contradictions in the discourses (Walshaw, 2013). As such, these discourses can compete for attention, and some teachers feel a conflict between national framework policies and the ideologies of a research project. Which one wins is related to sensitivity and identity of the teacher, where identity is “historically and situationally produced by discourses” (Walshaw, 2013, p.80). In the examples of these three teachers, it seemed clear which discourse won with both Angie and John. For Angie, her attention was not directed away from the pedagogical practice that she felt she was supposed to be doing. For John, he felt his attention was more naturally drawn to the discourse of the project. However, for Jenny, it seemed that she was still dealing with the competing attentions of the two discourses.

Walshaw (2010) remarked how some teachers are able to make their own choices pedagogically. Is it the case that John was able to make a pedagogical choice, whereas Angie and Jenny were unable to make a choice to move from an existing practice? The choices and decisions that teachers make in changing their practice are related to their identity as mathematics teachers (Lerman, 2009). Their identity is not some immutable essence of what a teacher is, but a social, discursive reality of what it means to be a teacher. The teachers’ identities legitimised a particular attitude (Jorgensen & Phillips, 2002). They were identifying with the idea of what a teacher is, and they viewed the changing practice from this reality. Their identity as a teacher had social and historical roots (Potter and Wetherell, 1987). The teachers’ understandings of what they did in the project were products of historical and cultural specific understanding of pedagogy. Their understandings of their role as the teacher, and of the students as learners, were related to ontological and epistemological views of mathematics.

A discursive pedagogical perspective recognises social, historical, and political dynamics of pedagogy (Walshaw, 2013). Teachers’ decisions in an intervention research project are linked to the political dynamics of the educational policy that is present at the time of the project, and some teachers feel the need to comply with this policy (Groundwater-Smith & Mockler, 2009). The identification of the teachers’ discourse positions enabled examination of the video recordings to move beyond descriptions of actions or experiences, that is what the teachers did, to an understanding of how the teachers constituted their experiences, and so to better understand any tensions the teachers had in transforming their practice. The interpretation of any tensions, and hence, identification of any perceived predicaments, acknowledged the influences of the ideologies in relation to social and historical influences on the teachers.

From a discursive pedagogical perspective, shifts in practice are viewed in the light of “a sensitivity regarding the complexity of the relationships that teachers form with mathematics pedagogy” (Walshaw, 2013, p.82). It cannot be said with any certainty why John felt he could make a shift towards dialogic teaching and merge his identity with a new discourse, why Angie did not make this shift and remained in an existing discourse, and why Jenny felt tensions with the existing discourse. However from a discursive pedagogical perspective it can be acknowledged that the teachers were, not only working with a shift in the students’ discourse, they were also working with a shift in their pedagogical discourses. A discursive pedagogical perspective has suggested that there were influences beyond the ideologies of the research project at play, and that these influences would have informed each teacher’s identity in a certain way.

In viewing the teachers' changing practices from this perspective, it can be said that the teachers were asked to attend to the discursive code in their classroom, and to shift their teaching from direct instruction to a more student-centred approach. Hence, the analysis can help to understand why some teachers made this shift, and where there was conflict. This account suggests, as Alexander (2008) also proposed, "that the tensions and ambiguities of classroom life can be understood as historically inevitable rather than, somehow, an aberration or the fault of the teacher" (p.103).

Such a discursive approach enables us to further understand why some teachers appeared to be resistant to changing their practice (Walshaw, 2013). This resistance was not just lack of commitment to the research project. Instead, the responses to the interviews showed how these three teachers related to, and managed, tensions in combining policy guidance on direct instruction and the researchers' ideology of dialogic teaching. Each teacher had chosen to invest in those discourses in a way that produced desirable changes for his or herself, and for their students. Whilst the shifts had been different, each teacher had perceived benefits, even if these benefits had not been as anticipated by the research team.

References

- Alexander, R. (2005). *Culture, dialogue and learning: Notes on an emerging pedagogy*. Paper presented at the International Association for Cognitive Education and Psychology University of Durham, UK.
- Alexander, R. (2008). *Essays on Pedagogy*. London, UK.: Routledge.
- Barnes, D. (1976). *From communication to curriculum*. Harmondsworth, Middlesex, UK.: Penguin Books Ltd. .
- Barwell, R. (2005). Language in the mathematics classroom. *Language and Education*, 19(2), 97-102. <http://dx.doi.org/10.1080/09500780508668665>
- Carr, D., & Kemmis, S. (1983). *Becoming Critical: Evaluation, knowledge and action research*. Victoria, Australia: Deakin University Press.
- Cobb, P., & Bauersfeld, H. (Eds.). (1995). *The emergence of mathematical meaning: Interaction in classroom cultures*. Hillsdale, N.J.: Lawrence Erlbaum Associates.
- Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in education. *Educational Researcher*, 32(1), 9-13. <http://dx.doi.org/10.3102/0013189X032001009>
- DCSF. (2010). Developing language and reasoning through guided group work in mathematics. Retrieved 1st March, 2012, from <http://webarchive.nationalarchives.gov.uk/20100612050234/nationalstrategies.standards.dcsf.gov.uk/node/19842>
- DfES. (2006). Primary Framework for Mathematics: Guidance paper - Calculation. Retrieved 6 October, 2008, from www.standards.dfes.gov.uk/primaryframework/downloads/PDF/calculation_guidance_paper.pdf
- Earl, L., Watson, N., Levin, B., Leithwood, K., Fullan, M., Torrance, N., . . . Volante, L. (2003). *Watching and Learning 3: Final Report of the External Evaluation of England's National Literacy and Numeracy Strategies*. Toronto: Ontario Institute for Studies in Education, University of Toronto.
- Ernest, P. (1994) Conversation as a metaphor for mathematics and learning. *Proceedings of British Society for Research into Learning Mathematics Day Conference*, Manchester Metropolitan University 22 November 1993. Nottingham: BSRLM, pp.58-63.

- Ewling, B. (2011). Direct instruction in mathematics: Issues for schools with high indigenous enrolments: A literature review. *Australian Journal of Teacher Education*, 36(5), 63-91.
- Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal for Research in Mathematics Education*, 35(4), 258-291.
<http://dx.doi.org/10.2307/30034810>
- Goos, M., Gailbraith, P., & Renshaw, P. (2002). Socially mediated metacognition: Creative collaborative zones of proximal development in small group problem solving. *Educational Studies in Mathematics*, 49(2), 193-223.
<http://dx.doi.org/10.1023/A:1016209010120>
- Groundwater-Smith, S., & Mockler, N. (2009). *Teacher professional learning in an age of compliance: Mind the gap*. Dordrecht, The Netherlands: Springer.
- Hanley, U. (2010). Teachers and curriculum change: Working to get it right. In M. Walshaw (Ed.), *Unpacking pedagogy: New perspectives for mathematics classrooms* (pp. 3-19). Charlotte, NC: Information Age.
- Hunter, R. (2005). *Reforming communication in the classroom: One teacher's journey of change*. Paper presented at the Building connections: Research, theory and practice: Proceedings of the 28th annual conference of the Mathematics Education Research Group of Australasia, Melbourne.
- Hunter, R. (2007). *Scaffolding small group interactions*. Paper presented at the Proceedings of the 30th Annual Conference of the Mathematics Education Research Group of Australasia, Hobart, TAS.
- Jorgensen, M., & Phillips, L. (2002). *Discourse analysis as theory and method*. London, UK.: Sage Publications Ltd.
- Kershner, R., Warwick, P., Mercer, N., & Kleine Staarman, J. (2012). Primary children's management of themselves and others in collaborative group work: 'Sometimes it takes patience ...'. *Education 3-13: International Journal of Primary, Elementary and Early Years Education*, iFirst Article, 1-16.
<http://dx.doi.org/10.1080/03004279.2012.670255>
- Lerman, S. (2001). Cultural, discursive psychology: A sociocultural approach to studying the teaching and learning of mathematics. *Educational Studies in Mathematics*, 46, 87-113. <http://dx.doi.org/10.1023/A:1014031004832>
- Lerman, S. (2009). Pedagogy, discourse, and identity. In L. Black, H. Mendick & Y. Solomon (Eds.), *Mathematical relationships in education: Identities and participation* (pp. 147-155). London, UK.: Routledge.
- Littleton, K., & Mercer, N. (2013). *Interthinking: Putting talk to work*. Abingdon, Oxon, UK.: Routledge.
- Mercer, N. (2000). *Words and Minds: how we use language to think together*. London: Routledge. <http://dx.doi.org/10.4324/9780203464984>
- Mercer, N. (2008). *Three kinds of talk*. Retrieved 30 January 2012, from http://thinkingtogether.educ.cam.ac.uk/resources/5_examples_of_talk_in_groups.pdf
- Mercer, N., & Sams, C. (2006). Teaching children how to use language to solve mathematics problems. *Language and Education*, 20(6), 507-528. <http://dx.doi.org/10.2167/le678.0>
- Merttens, R., & Wood, D. (2000). Sea changes in mathematics education: An elaboration of aspects of the National Numeracy Strategy. *Mathematics Teaching*, 172, 13-17.
- Murphy, Wegerif, R., & Fisher, R. (2010). The Talking Counts Project. from <http://education.exeter.ac.uk/projects.php?id=490>
- Pimm, D. (1987). *Speaking mathematically: Communication in mathematics classrooms*. London, UK.: Routledge and Kegan Paul.

- Pratt, N. (2006). 'Interactive' teaching in numeracy lessons: what do children have to say? *Cambridge Journal of Education*, 36(2), 221-235. <http://dx.doi.org/10.1080/03057640600718612>
- Radford, L. (2006). The anthropology of meaning. *Educational Studies in Mathematics*, 61(1-2), 39-65. <http://dx.doi.org/10.1007/s10649-006-7136-7>
- Sawyer, A. (2006). *Unpacking the rules of class discussion: Young children learning mathematics within a community of inquiry*. Paper presented at the Identities, cultures, and learning spaces Proceedings of the 29th Annual Conference of the Mathematics Education Research Group of Australia, Canberra, Australia.
- Seeger, F. (2011). On meaning making in mathematics education: social, emotional, semiotic. *Educational Studies in Mathematics*, 77, 207-226. <http://dx.doi.org/10.1007/s10649-010-9279-9>
- Sfard, A. (2001). There is more to discourse than meets the ears: Looking at thinking as communicating to learn more about mathematical learning. *Educational Studies in Mathematics*, 46(1-3), 13-57. <http://dx.doi.org/10.1023/A:1014097416157>
- Smith, F., Hardman, F., Wall, K., & Mroz, M. (2004). Interactive whole class teaching in the National Literacy and Numeracy Strategies. *British Educational Research Journal*, 30(3), 395-411. <http://dx.doi.org/10.1080/01411920410001689706>
- Walkerdine, V. (1990). *The Mastery of Reason: Cognitive development and the production of rationality* London, UK.: Routledge.
- Walls, F. (2005). *Challenging task-driven pedagogies of mathematics*. Paper presented at the Proceedings of the Annual Conference of the Mathematics Education Research Group of Australasia. Building Connections: Research, Theory and Practice, Melbourne, VIC, Australia.
- Walshaw, M. (2010). Learning to teach: Powerful practices at work during the practicum. In M. Walshaw (Ed.), *Unpacking pedagogy: New perspectives for mathematics classrooms* (pp. 109-128). Charlotte, NC: Information Age.
- Walshaw, M. (2013). Explorations into pedagogy within mathematics classrooms: Insights from contemporary inquiries. *Curriculum Inquiry*, 43(1), 71-94. <http://dx.doi.org/10.1111/curi.12004>
- Walshaw, M., & Brown, T. (2012). Mathematics education and contemporary theory: guest editorial. *Educational Studies in Mathematics*, 80, 1-8. <http://dx.doi.org/10.1007/s10649-012-9397-7>
- Wells, G. (Ed.). (2001). *Action, talk and text: Learning and teaching through inquiry*. New York, NY.: Teachers College Press.
- Williams, P. (2008). Independent Review of Mathematics Teaching in Early Years Settings and Primary Schools Nottingham: DCFS Publications.
- Wodak, R., & Meyer, M. (2009). *Methods of critical discourse analysis, Second Edition*. London, UK.: Sage Publications Ltd.
- Wood, T., & McNeal, B. (2003). *Complexity in teaching and children's mathematical thinking*. Paper presented at the Proceedings of the 27th annual conference of the International Group for the Psychology of Mathematics Education, Honolulu, HI.